THE JOURNAL

OF THE

ROYAL DUBLIN SOCIETY.

NOTICE.

It is to be understood that the Society is not responsible for any opinion or statement of facts in the Essays published in this Volume. The Authors of the several Papers are alone answerable for their contents.

THE JOURNAL

OF THE

ROYAL DUBLIN SOCIETY.

VOL. VI.

DUBLIN:
HODGES, FOSTER, & CO., 104, GRAFTON-STREET,
BOOKSELLERS TO THE ROYAL DUBLIN SOCIETY.
LONDON: SIMPKIN, MARSHALL, & CO. EDINBURGH: JOHN MENZIES & CO.
1875.

DUBLIN:
Printed at the University Press,
BY M. H. GILL.

No. XL.] [Price 2s.

THE JOURNAL

OF THE

ROYAL DUBLIN SOCIETY.

CONTENTS:

	PAGE.
1. Professor Hennessy on the Climate of Ireland with reference to the Cultivation of Flax,	1
2. Mr. Draper on Colours from Coal Tar,	7
3. Mr. Tichborne on Atmospheric Dust,	22
4. Dr. Macalister on Comparative and Homological Anatomy,	35
5. Dr. Moore on the destruction by a Fungus of a large Screw Pine in the Botanic Garden,	50
6. M. Charlier on a New Method of Horse Shoeing,	52
7. Mr. Andrews on Liquid and Gaseous Matter,	55
8. Mr. Kirby's List of the Species of Sphingidæ in the Collection of the Royal Dublin Society,	60
9. Mr. Kirby's List of the Species of Papilioninæ in the Museum of the Royal Dublin Society,	63
10. Mr. Kirby on Three Species of Trap-door Spiders in the Roy. Dub. Soc. Collection,	77
11. Mr. Ball's Account of Experiments upon Mechanical Efficiency of Pulley Blocks,	80
12. Dr. Reynolds on the Nature and Constitution of some new Compounds of Mercury,	86
13. Messrs. Stoney and Reynoldson the Absorption Spectrum of Chlorochromic Anhydride,	83
14. Dr. Reynolds' Mineralogical Tables,	84
15. Professor Hull on the Coal-fields of England,	141
16. Return of Donations to the Royal Dublin Society,	142
17. Intelligence :—	
School of Art,	159
Evening Meetings,	181
Appendix—Meteorological Journal from April, 1870, to May, 1871,	i

DUBLIN:

HODGES, FOSTER, AND CO., 104, GRAFTON-STREET,

BOOKSELLERS TO THE ROYAL DUBLIN SOCIETY.

LONDON: SIMPKIN, MARSHALL, AND CO. EDINBURGH: JOHN MENZIES.

1872.

M. H. Gill, Printer to the Royal Dublin Society.

Royal Dublin Society.

FOUNDED 1731. INCORPORATED 1749.

The Society consists of Members, who, on being proposed and seconded, are elected at the next Meeting by Ballot, previously to which the Fees, as follows, must be lodged with the Treasurer:—

Life Membership, ...	£21	0	0
Annual Membership (with £3 3s. Entrance Fee),	2	2	0

Annual Subscriptions due on 1st January. Persons in arrear on the 1st April cease to be Members.

Annual Members may at any time become Life Members upon payment of £15 15*s*., £10 10*s*., or £5 5*s*., according to standing.

I.—Meetings of the Society and the Council.

1. *Stated and Ordinary Meetings.*

The Society meets at 3 o'Clock P. M., pursuant to the Charter, on the second Thursday in November, and the First Thursday in March and June.

The Council meets during the Session at Three o'Clock on every Thursday not occupied by the Meetings of the Society.

2. *Evening Scientific Meetings.*

Meetings of the Society, for the reading and discussion of Papers on Scientific subjects, are held on the third Monday in each Month during the Session.

Persons desirous to read Communications must submit their Papers to the Committee a week, at least, previously, for examination and approval.

The Copyright of all Papers read becomes the property of the Society; and such as are considered suitable for the purpose will be published in the Journal of the Society.

Except under special circumstances, no person can be permitted to occupy the Meeting in reading a Paper for a longer period than half-an-hour; and the Society will not be held responsible for any opinions advocated in the communications read.

Each Subscriber of 5*s*. to the Refreshment Fund is entitled to Tickets, to admit Visitors, at 6*d*. each; or to twelve for 5*s*., available for any of the ordinary Meetings throughout the Session.

The Standing Committees.

Six Standing Committees are annually elected, as follows:—1. Agriculture; 2. Botany; 3. Fine Arts; 4. Library; 5. Natural History; 6. Practical Science.

[*For continuation, see page 3 of Cover.*

THE JOURNAL

OF THE

ROYAL DUBLIN SOCIETY.

I.—*On the Climate of Ireland with reference to the Cultivation of Flax.* By Professor H. Hennessy, F. R. S., Vice-President of the Royal Irish Academy.

[Read Monday evening, March 21, 1870].

My object in submitting the present paper to the Society is to endeavour to furnish an answer to the question, whether the climate of Ireland is favourable to the general cultivation of flax throughout the island. I should have scarcely ventured to enter on a question of flax culture, which might have been naturally left to those who are practically engaged in its management, had not doubts been expressed in a report addressed by an eminent authority on statistics to the Government as to the suitableness of the climate in some parts of Ireland for growing this crop,* and as the study of our climate has occupied my attention for several years, it seemed to me desirable that an effort should be made by me towards the removal of any hesitation on a matter of such national importance.

The circumstance that the coasts of our island are bathed by seas which are influenced by the most remarkable heat-bearing tropical current on the surface of the globe, gives to our climate what may be called a representative character. The waters which surround our shores give out for our benefit a portion of the heat which they have absorbed within the tropics, and which, owing to the thermal properties of water, had been retained until the currents reached our latitude. In this way has arisen not only our superior mean annual temperature, as compared to that of other places under the same parallel of latitude, but also the peculiarly reentrant character of the isothermal lines which

* See Dr. Hancock's Report to the Under-Secretary for Ireland in the Appendix to Report of the Joint Committee on Flax Culture, for 1865.

represent the distribution of heat over the surface of Ireland. This is shown in accompanying map; the lines in question are in red, and the exterior blue lines show the distribution of temperature in the water around the coast. From the same cause has followed the small difference between our summer and winter temperatures, and the small diurnal range of the thermometer. These thermal conditions, combined with the abundant precipitation of moisture on our soil, exercise a most important influence on the growth of every kind of crop produced in Ireland.

The unfitness of our climate for the widespread and profitable culture of the most valuable of cereal crops, wheat, has led to the discouragement of tillage, and a development of agriculture in its most imperfect shape, namely, pasture farming. This circumstance, as well as the great intrinsic importance of flax, so appropriately called "the golden crop" by Mr. Warden, of Dundee, in his work on the linen trade, furnishes an additional reason for the interest which is excited by this question.

The flax plant, like almost all the useful plants in cultivation, is not a native of Ireland, and although it has been introduced here at a very early period, it is rarely, if ever, found growing wild. It is an annual, and could not become permanently naturalized unless the summers were always sufficiently hot to thoroughly ripen the seeds. Although this does not occur generally in Ireland, it will yet appear that the climatal conditions for the growth of the best varieties of flax are to be found nearly all over the island. It is generally acknowledged that flax requires a considerable amount of moisture, combined with a moderate temperature in the early stages of its growth.

According to Decandolle (Bib. "Universelle Archives," vol. xxiv., 1865), flax germinated in 34 days, at a constant temperature from 1° 4 to 1° 9 C., or from 34° 5 to 35° 4 Fahrenheit. With temperatures from 2° 8 to 3° 2 C., [36° 9 and 37° 6 F.], it germinated in 17 or 18 days, in great abundance. At 4° 7 and 4°9 [40° 5 to 40° 8 F.], in 17 days. At about 42° 3 F., if watered at the same temperature, it germinated in 6 days, and at 48° 2 F., in 2 days. These results conclusively show that a moderate and steady temperature favours the rapid germination of flax.

If a long continuance of dry weather should occur, combined with a hot sun, after the plant has reached a height of about three inches, and before it has been able to shade the soil about its stem, the ground becomes dried up, and vegetation ceases. Failures of the crop, from dry spring weather, not unfrequently occur in what are acknowledged as pre-eminently flax-growing countries on the Continent; and, as might be anticipated, it will appear that the spring in Ireland, which is generally more moist, is also far more favourable to the early growth of the plant. In its more mature stages, the flax plant requires moderate summer warmth for the proper development of its fibre. The hot summers of some flax-growing countries are unfavourable to the toughness and fineness of the fibre, and their produce is deficient

in the much-prized flexibility and softness of the fibre of flax grown under more temperate conditions.

In Egypt, where flax is sown in November, and pulled in March, when the temperature is 70°, and upwards, it seems that the plant does not attain that degree of fineness required for spinning it into very small sizes of yarn.

It has been justly remarked that the principal flax producing districts in Europe are not much devoted to wheat producing, and that the principal wheat districts do not grow flax. From this proposition it has been rather hastily concluded, that comparatively good wheat-producing localities in Ireland are not adapted to the growth of the flax crop. In other words, it has been assumed that parts of the South of Ireland are too warm for the remunerative culture of flax. A comparison of our climate with that of the most remarkable flax-growing districts will not only dispel this illusion, but will show that Ireland is, in some respects, superior to all other countries in its climatal advantages with reference to the growth of this valuable crop. The conditions of temperature during the months most important for the flax crop are shown in the following tables:—

TEMPERATURE TABLES FOR THE FLAX GROWING MONTHS, IRELAND.

	March.	April.	May.	June.	July.	August.
	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Belfast,	42·0	46·3	51·4	56·9	58·7	58·5
Portrush,	42·9	45·7	50·2	55·3	56·5	58·8
Donaghadee,	43·3	46·6	50·8	55·8	57·0	58·8
Buncrana,	43·3	45·4	50·5	55·8	56·4	59·3
Armagh,	42·5	45·4	50·3	56·2	57·1	58·6
Killough,	43·9	46·7	51·9	55·2	58·1	59·1
Markree,	42·3	45·3	50·1	55·7	56·6	58·7
Dublin,	44·0	46·8	52·5	58·8	60·2	62·0
Portarlington,	40·5	43·1	49·1	54·8	57·3	57·7
Athy,	41·8	45·4	50·6	56·9	58·2	60·8
Courtown,	44·3	46·6	52·5	57·3	59·5	60·7
Innisgort,	46·2	47·3	52·1	56·5	58·3	60·9
Kilrush,	46·2	48·4	53·3	56·1	56·8	58·9
Galway,	44·0	50·0	53·9	57·6	59·7	56·5
Limerick,	44·2	48·3	53·2	59·1	58·9	59·0
Cahirciveen,	46·4	48·5	58·9	58·2	60·2	62·0
Castletownsend,	46·1	47·9	53·6	57·0	60·7	61·8
Queenstown,	45·5	49·7	54·3	58·9	61·4	61·9
Dunmore,	44·8	47·4	53·3	58·2	61·6	62 3

BALTIC PROVINCES OF RUSSIA.

	March.	April.	May.	June.	July.	August.
	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Riga, ...	27·0	38·1	51·6	58·3	64·9	61·7
Revel, ...	26·1	34·9	46·8	56·8	63·6	59·7
Libau, ...	..	..	50·6	57·6	64·9	62·4
Mitau, ...	29·6	40·4	51·8	60·6	63·5	62·2
Baltisch Port . . .	24·0	34·6	46·0	59·1	64·2	62·7

BELGIUM.

	March.	April.	May.	June.	July.	August.
	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Brussels, ...	41·9	48·6	56·1	63·1	64·9	64·4
Alost, ...	41·4	46·9	56·3	64·3	67·3	65·8
Ghent, ...	41·6	50·7	59·9	67·3	68·9	67·8
Ostend, ...	42·3	50·1	56·8	61·8	64·1	64·0
Furnes, ...	43·1	45·8	53·8	60·1	66·5	68·9
Ostin, ...	36·3	45·0	53·8	59·4	66·2	62·6
Leuze, ...	41·0	48·4	57·5	62·4	69·1	67·3
Louvain, ...	40·5	48·6	57·0	62·9	64·6	64·2
Tirlemont, ...	38·5	46·5	56·8	62·4	68·9	65·6
St. Trond, ...	39·4	48·4	57·0	62·6	65·8	64·6
Liege, ...	41·0	48·8	57·8	64·3	66·5	64·2
Namur, ...	39·7	47·8	56·1	63·9	66·0	64·6
Chimay, ...	35·6	42·0	54·9	60·8	67·5	62·9
Habay la Neuve, . .	36·0	42·8	55·3	56·8	67·1	62·0
Rolle, ...	..	..	..	61·9	68·5	66·4
Verviers, ...	..	..	..	62·1	68·2	64·6
Stavelot, ...	..	..	..	63·9	65·5	63·9
Bastogne, ...	..	..	..	58·6	60·4	61·9
Arlon, ...	..	..	..	57·2	62·4	56·0

HOLLAND.

	March.	April.	May.	June.	July.	August.
	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Amsterdam, . . .	39·6	46·7	53·6	61·2	64·5	64·0
Assen, ...	38·0	45·8	53·4	61·4	64·0	64·2
Groningen, ...	37·8	46·5	54·8	62·6	63·9	63·0
Helder, ...	39·5	45·8	52·3	59·3	64·0	64·4
Leuwarden, ...	37·9	44·8	52·0	59·1	63·5	62·6
Maestricht, ...	41·0	49·4	57·3	63·2	68·6	67·6
Nimwegen, ...	39·1	47·4	54·6	61·4	63·8	64·7
Flushing, ...	40·6	48·2	54·3	60·7	63·6	63·9

EGYPT.

	Nov.	Dec.	Jan.	Feb.	March.
	Degrees.	Degrees.	Degrees.	Degrees.	Degrees.
Cairo,	64·7	[illegible]9·4	56·3	55·8	63·9
Alexandria,	69·5	62·7	64·0	66·9	72·0

The results relating to Ireland have been compiled chiefly from publications by the Rev. Dr. Lloyd, and from manuscript reductions in my possession, based on the observations taken during the Ordnance Survey, and on those taken at Queen's College, Belfast, under the superintendence of the Vice-President; and at Galway, under the superintendence of Professor Curtis; those for Russia, from the Annals of the Royal Observatory of St. Petersburg; for Belgium, from various works of M. Quetelet; for Holland, from memoirs by M. Buys Ballot, Director of the Observatory of Utrecht; and for Egypt, from M. Dove's paper, in the "Transactions of the Academy of Berlin."

The temperatures have in all cases been reduced to Fahrenheit's scale.

From these results we draw two important conclusions:—

1. The temperature of the early spring months in Ireland is higher than that of the same months in the most important flax-producing countries of Europe, and therefore an earlier sowing of flax becomes admissible in Ireland.

2. The summer temperatures of all parts of Ireland are, more or less, below those of the continental flax districts. The mean annual temperature of these districts is in general inferior to that of Ireland, and hence, probably, the erroneous conclusion that our climate was a little too warm for the thoroughly remunerative growth of flax. It is manifest that the temperatures of the months during which the flax is germinating, growing, and ripening, are the conditions which govern its production, and not the mean annual temperature, and therefore our climate is at no time too warm for the crop. The more moderate temperature of our summers compared to continental summers, instead of being injurious, ought to be favourable to the development of very fine flexible and strong fibres, which are best adapted for the smallest yarn, and therefore likely to fetch a high price in the market.

Although the superior moisture of our climate, contrasted with that of the continental flax districts, can scarcely be questioned, I have made the following comparison of the results obtained by rain gauges in Ireland with similar results in the districts alluded to:—

RAINFALL IN INCHES DURING THE FLAX-GROWING MONTHS.

IRELAND.

	March.	April.	May.	June.	July.	August.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Cork, ...	3·20	2·50	2·20	2·10	2·60	3·20
Valentia, ...	5·90	3·30	2·50	4·00	3·60	7·40
Limerick, ...	2·90	2·50	2·10	2·30	3·20	3·80
Portlaw, ...	4·00	2·38	3·42	2·63	2·44	3·20
Ennis, ...	2·30	2·00	2·80	4·00	3·30	3·30
Gort, ...	3·47	2·68	3·00	1·82	1·93	3·52
Galway, ...	3·60	2·50	3·40	3·20	3·20	4·60
Killaloe, ...	5·10	2·80	3·00	4·00	3·60	6·00
Doo Castle, ...	2·97	2·45	2·73	2·60	3·19	3·58
Hazlewood, . . .	3·11	2·20	3·16	2·22	3·40	3·80
Markree, ...	2·60	2·50	1·80	3·80	3·40	3·40
Belturbet, ...	2·40	1·70	2·20	3·80	4·20	4·20
Armagh, ...	2·30	2·60	1·90	2·70	2·80	2·90
Toom, ...	1·70	1·20	1·80	2·80	2 80	3·30
Belfast, ...	2·20	2·90	1·00	2·70	2·70	2·80
Dublin, ...	1·50	2·10	2·20	2·30	2 80	3·00

BELGIUM.

	March.	April.	May.	June.	July.	August.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Brussels, ...	1·97	2·00	2·24	2·52	2·70	2·85
Ghent, ...	1·90	1·92	2·36	2·94	2·91	3·00
Alost, ...	1·94	1·68	1·98	3·63	3·38	2·68
Liege, ...	1·88	2·52	2·62	3·16	2·60	3·35
Namur, ...	1·41	1·90	2·14	2·22	2.05	2·40
Louvain, ...	1·98	2·00	2·15	3·08	2·72	3·05
St. Trond, ...	1·56	2·95	2·38	2·43	1·98	3·70

BALTIC PROVINCES OF RUSSIA.

	March.	April.	May.	June.	July.	August.
	Inches	Inches.	Inches.	Inches.	Inches.	Inches.
Revel, ...	1·28	0·78	1·40	1·57	1·22	0·57
Riga, ...	1·65	1·99	0 99	2·12	2·09	2·14
Libau, ...	1·51	1·44	1·19	1·94	2·75	1·28
Mitau, ...	0·77	1·03	1·50	1·76	2·75	2·44

As might be expected, our rainfall is in excess of that of the Continental flax districts throughout the whole flax-growing period.

In this respect our advantage during the spring months is unquestionable, and thus we need not apprehend the failure of a flax crop from absence of a supply of moisture to the young plants, as sometimes occurs on the continent. As flax plants, when not grown for seed, cannot be injured by wet summers, it follows that, unless where the production of seed is the object to be attained, our moist climate is not a serious drawback to flax culture.

The abstracts of the Reports of Flax Instructors, published by the joint Committee of this Society and the Royal Agricultural Society, seem to confirm these conclusions. They show that the most satisfactory results have been obtained in districts of the south and west, where, according to the groundless speculations already alluded to, the crop should be expected to produce the smallest returns, but where, if my views are correct, flax culture should be firmly and largely encouraged by all who are directly interested in the increase of agricultural prosperity.

As thorough confidence in the success of any undertaking is one of the best securities for its realization, I may be permitted to hope, that the conclusion to which I have been led—namely, that the climate of Ireland, on the whole, is pre-eminently favourable to the culture of flax—may, by assisting to remove any doubts upon the question, also forward the great object of inducing landowners and farmers to bring "the golden crop" into very general cultivation.

II.—On the Colours from Coal Tar, *being a Lecture delivered before the Royal Dublin Society, on Saturday, May 7th,* 1870. By Harry N. Draper, F. C. S.

Ladies and Gentlemen,

A few evenings since, when I was thinking how I might best place before you this subject of Colours from Coal Tar in an instructive, and at the same time, if possible, an interesting manner, I chanced, in a very charming book, upon a passage which, with your permission, I will read to you.

"Yesterday forenoon, writes a friend, I went to the South Kensington Museum. It is really an absurd collection—a great deal of valuable material, and a great deal of perfect rubbish. The analyses are even worse than I was led to suppose. There is an *analysis of a man.* First a man contains so much albumen, and there is the albumen; so much phosphate of lime, fat, hæmatin fibrine, salt, &c., &c.; then in the next case, so much carbon, so much phosphorus, a bottle with sticks of phosphorus, so much potassium; and there is a bottle with potassium, calcium, &c. They have not bottles of oxygen, hydrogen, and chlorine, but they have cubical pieces of wood on which is written, 'The quantity of oxygen in the human body would occupy the space of 170 cubes of the size of this.' What earthly good can this do any one?"—Brown, *Horæ Subsecivæ.*

Now, when I tell you, that, did I not stand in such close proximity to the admirable museum of this Society, and in awe of the unfavourable opinion of some friends of mine whom I see here, and whose opinion I respect, I should be much disposed to say "that, very little good indeed;" you will understand that it is not without diffidence that I ask your attention to the somewhat formidable array of specimens which you see upon the table, or to the diagrams which hang against the wall. It is not that I have large sympathies with those, who, thinking the best part of a scientific lecture to be the experimental one, are ever on thealert for brilliant coruscations of light and for explosions, but that I realize most fully the great difficulty of conveying anything like an accurate idea of complex chemical changes, with the opportunities and within the limits of a single lecture; and when we have, too, in the same hour, to occupy ourselves with the practical results of an important industry like this. However, as I have introduced the diagrams to your notice, it is but fair that I should be their apologist; and while, I think, I may say that they need not be a cause of uneasiness to us, I hope that when (as is but too probable) I come to use hard words, they will be a positive help, and give us some notion of what the hard words mean. And, as regards the specimens, I think, when I say that each of them represents a fact, and often a very beautiful fact in chemistry, that each one of them has its own peculiar application in the arts or manufactures, and that they are, without exception, products of that wonderful fossil flora which we call Coal, you may be disposed to view them indulgently. I shall hope, too, to give them new interest in your eyes as we proceed; and it will be well if, at the outset, we get a clear idea of the object before us. We propose to trace the *useful*, as represented by this black, unsightly coal, in its progress towards the *beautiful*, as exemplified by the brilliant dyes with which we have been familiar during the past fourteen years. The mind, even when accustomed to chemical changes, and trained by experience to expect what would otherwise be startling results, does not easily grasp the conception that the millions of tons of coal which, in these islands, await the hands of the miner, represent a vast magazine, not only of light and heat, but of colour-giving substances, which vie in splendour with the tints of the most gorgeous exotics, or the varied plumage of tropical birds.

The connexion of colour with light is inseparable. We cannot imagine its independent existence. It is not only when, as you have seen in some of the earlier lectures of this course, a ray of light is intercepted by a prism, that its velocity is altered, and that magnificent spectrum whose tints never weary us, extends itself upon the screen; but nearly all bodies in nature split up white light, and in effect these differ only from prisms in that they absorb some rays and reflect others. That this is so we know; but though we may scarcely adopt the fanciful hypothesis of Darwin, whose "Etherial powers"

"Cling round the aerial bow, with prisms bright,
And, pleased, untwist the sevenfold threads of light;
Eve's silken couch with gorgeous tints adorn,
And fire the arrowy throne of rising morn,"

we really know little more than we might thus express, and cannot predict, either from the shape, physical condition, or chemical constitution of a body, whether it shall appear to our eyes red, yellow, or blue. But grant white light and anything which will absorb a part of it and you have colour. But does light, upon which so marked a change is effected when this partial absorption takes place, itself effect no change when it is, not partially, but wholly absorbed by the bodies upon which it falls? All nature gives an affirmative reply. The snow-drop will flourish in the most secluded corner of the garden, and the wood-sorrel, we know, puts forth its pale blossoms in the shadiest dell; but it is in the full blaze of the tropical sunlight that cactus and aloë assume their vivid tints and the orchis takes its rainbow hues. Shall we, then, allow imagination too much rein if we think that centuries ago, when that which is now a coal-field was a waving forest, the light drunk in by every leaf did something more than clothe the copse in sombre green. May we not suppose that just as a logwood tree or an indigo plant of to-day returns in colouring matter the work done by the light it absorbs; these dark tracts of pines no less stored up their colour-giving substances but withheld them for a future age. And if we turn from the domain of fancy to that of fact, we see, as has been well pointed out by Hofmann, how much the practical science of to-day tends to turn to the vast storehouses of raw material which the mineral kingdom affords, and to form from inorganic bodies the most rare and costly products of organic life. Already, as he says, we have found the potash salts, which were hitherto obtained only from plants, in that great magazine of potash, the ocean; and paraffin and allied fatty bodies obtained from coal have already supplanted, to a very large extent, the fats and oils for which we were accustomed to look to animal and vegetable sources alone. So, in the same way, we have now some other things which, as flavours and perfumes, appeal to our senses of taste and smell, derived from mineral sources. It is not, then, after all, so very strange that we should seek and find *colour* in *coal.*

"Coal and Iron," it has been well said, "are kings of the earth;" and as we traverse to-day the desert of hard names and abstract fact which separates Coal-tar from Colour—a desert by the way in which there are a few pleasant oases—we shall do well to remember how much wealth from this source alone lies stored up in the coal-fields of Great Britain; and, perhaps, there are few cases we could select in which the contrast between the value of two substances is greater than it is between coal-tar and say, for example, purple dye: the first a fit type, if not of complete uselessness, at least of offensiveness; and the last so prized, that a pound of wool dyed with the Tyrian purple, which, as we know, was obtained from a shell fish—the *murex*—sold at the time

when Augustus reigned in Rome, for a sum equivalent to £30 of our money. As I have mentioned this, it is, perhaps, but fair to say, that the purple of Tyre had an advantage which, in some degrees, compensated for its enormous price. We read that, when the Greeks sacked the treasury of Darius, they found a quantity of cloth dyed with this murex purple, which had retained all its brilliancy of colour after the lapse of 100 years. It was, therefore, essentially what ladies call a "fast" colour. It may not be out of place to note, that nearly all the dyes with which we are familiar are of comparatively recent introduction. We never hear of woad now, but this favourite dye of our barbaric ancestors was only replaced by indigo in the reign of Elizabeth. And now, in our own day, indigo is being slowly but surely supplanted by the dyes which form a part of the wonderful series of "Colours from Coal-tar."

And now we will endeavour, if you please, to follow the progress of this industry. All who hear me know, that in the manufacture of gas, coal is distilled in large retorts, made either of fire-clay or iron, from each of which a vertical tube rises. A number of these retorts are arranged together in a furnace; the retorts are made red-hot, and distillation at once commences.

Both the gas and the oily products of the coal pass up a vertical pipe, and (as this bends on itself) down again into what is called the "hydraulic main." Here all which is not gas condenses, and as the condensed liquid accumulates, it flows into a tank prepared for it. Coke alone remains in the retort. The condensed liquid is *Coal Tar*—the body which interests us to-day. Now, this coal tar is, by distillation at a lower temperature, itself separable into two bodies—*pitch* and *tar oil*. The pitch is, as we know, used for the formation of the artificial asphalt, employed for footways, and in the manufacture of coarse black paints or varnishes. In this and other ways all the pitch which it was worth while to make found an outlet; but, because there was almost no other use for the tar oil than "creosoting" timber, it was almost without value. A glance at the diagram which we have here, will show us that coal-tar oil is by no means a simple body. Hofmann indeed, very properly speaks of it as "one of the most wonderful productions in the whole range of modern chemistry." We must not forget that not one of all these substances tabulated here, exists *as such* in the coal itself. Indeed, if we were not aware what remarkable changes the simple application of heat is capable of making in most bodies, we should not be prepared for such a splitting up of what, at first sight, seems a very simple body indeed, into all these compounds. This action of heat sometimes shows itself in a very remarkable way. Here is a body: it is a compound of cyanogen and sulphur; and you see that, as we have it here, it consists of small white lumps of a loosely-aggregated powder. Now, if I apply heat to this body, it changes its form in a very remarkable manner; and, having seen this change of form, you will readily understand that its chemical properties and chemical composition have also undergone complete change. So it is with coal: the mere application of heat, to a

certain degree, not only changes its form, but resolves it into all these bodies, each of which has some important chemical difference from its neighbour.

Perhaps, if we only knew how to go to work, we should discover that there are very few things in nature from which we could not obtain colour. But the tendency of these component parts of coal-tar to form coloured compounds is very remarkable. I might show you this by more or less elaborate methods, with almost any one of them; but here is one of the simplest examples. I mix a few drops of this body, which, as we shall have more to say to it presently, I will not describe now. I mix it with the water in this jar, and then add a solution of a persalt of iron. You see we have a violet coloration at once developed. But there are *five* constituents of tar, in which the tendency to give colour is so very marked that all the interest of coal-tar, as a practicable source of colour, centres in them. These five bodies are Benzol, Toluol, Phenol, Naphthalin, and Anthracen; and as it is from these alone that the coal dyes are obtained, we have arranged them here on a separate diagram, in which each is shown, with the principal colours derived from it. You will see, also, specimens of each of these bodies on the table, and will observe some characteristic points of difference, even in their appearance.

Now, in separating these substances from coal-tar oil, advantage is taken, firstly, of differences of boiling point; and, secondly, of the various behaviour of these bodies with acids and alkalies. Glancing at the diagram, we see, for instance, that *benzol* boils at 84°; *toluol* at 114°, and *phenol* at 188°; so that, if we subject a mixture of these three bodies to distillation, we shall obtain—first, the benzol; then, as the temperature increases, the toluol; and, finally, when the thermometer reaches 188°, the phenol.

To illustrate the manner in which the chemical method of separation is applied, we have arranged here some glasses in which benzol, aniline, and phenol, have each been shaken with an acid and an alkali. You will observe that, in the case of benzol, it floats indifferently upon the surface of both acid and alkali; but that the aniline, while untouched by the alkali, is dissolved by and mixes with the acid. The behaviour of phenol is exactly the reverse of this, for the alkali dissolves, while the acid is without action on it. You see in this experiment a general outline of the method by which coal-tar is made to give up the different bodies which it contains. We must, however, pass with some rapidity into detail; and, bearing in mind that we have here to do with but five constituents of coal-tar, speak of them one by one as they come before us in their aspect of sources of colour.

By far the most important of these is that which we have here, benzol. To obtain it, the coal-tar oil is distilled by steam heat, and all those portions which boil under 90° on the centigrade scale, are collected. Pure benzol is a very volatile, inflammable fluid, of a peculiar odour, forcibly recalling that of coal gas. It boils at 81° centigrade. It is very much used in the arts as a solvent of india-rubber; and, under

the name of *benzine collas*, we are familiar with its employment for the removal of grease stains. When cooled to about the freezing point of water, it forms very beautiful crystals. This fact is sometimes taken advantage of to effect its separation from the other bodies which accompany it in coal-tar oil. I must ask you to remember, as this is the point from which all we have to say about the colour-giving matters of coal-tar diverges, that benzol was discovered in 1825 by Faraday, who found it as a product of the action of a high temperature on benzoic acid. It is, however, to Hofmann that we owe its recognition as one of the products of the distillation of coal. This discovery was made in 1845.

Much lower down in the diagram you will see the name of another body, ANILINE, and to this substance I must ask your particular attention. Aniline was discovered in 1826, by Undervorben, who found that indigo gave it as one of the products of its distillation. It has been successively known by the names of "crystalline" and "kyanol," and received its present name from Fritzsche, who, obtaining it by a process only slightly differing from that of Undervorben, named it from *anil*, the Portuguese name of indigo. Aniline, as you see by the diagram, is one of the tar oil constituents; but, as it exists there in very small quantities indeed, it is fortunate that we are not dependent upon this source of it. It is to Zinin that we owe the knowledge of the simple relations between benzol and aniline, and the fact that the former can be converted into the latter with the utmost readiness.

On referring again to the diagram, we observe that the chemical composition of benzol is thus represented:—

$$C6\ H6.$$

Now, when benzol is mixed with strong nitric acid, a very violent action takes place, and an orange-coloured liquid is formed. When the orange liquid is poured into water, a yellow oil separates and falls to the bottom. This is nitro-benzol. The following equation represents the change which takes place:—

$$\underbrace{C6\ H6}_{\text{Benzol.}} + \underbrace{HNO_3}_{\text{Nitric Acid.}} = \underbrace{C6\,H_5NO_2}_{\text{Nitrobenzol.}} + \underbrace{H_2O}_{\text{Water.}}$$

Nitrobenzol differs remarkably from benzol in its properties. It is, as you see, heavier than water, and its odour is remarkably fragrant, resembling to a considerable extent that of oil of bitter almonds. It is, indeed, known in commerce as artificial bitter almond oil, and is used as a perfume for soap. But it is merely as a step in the process of change which benzol undergoes in becoming aniline that nitrobenzol now interests us. When it is submitted to the action of hydrogen in that condition which chemists call *nascent*, that is just at the instant of its liberation, all the oxygen of the nitrobenzol is removed in the form of water, and, two atoms of hydrogen being introduced, we get *aniline*.

$$\underbrace{C6\,H_5NO_2}_{\text{Nitrobenzol.}} + H6 = \underbrace{C6\,H_7N}_{\text{Aniline.}} + 2H_2O$$

The method of effecting this change, now universally adopted, is that of Bechamp, which consists in distilling the nitrobenzol with iron filings and acetic acid.

The fact that, under certain circumstances, and more particularly when heated with any substance capable of affording oxygen to it, aniline gave rise to colour, was long known; but no one seems to have attempted to fix any of these colours. It was Runge who first noticed the action of chloride of lime upon aniline; and as this was perhaps the earliest experiment in which aniline was seen to give colour, we may repeat it. Here is a solution of a salt of aniline, and you will see that when we add to it a weak solution of chloride of lime, a blue coloration is at once produced. It is important not to add too much of the chloride, for the very agent which produces the colour is most active in destroying it. But though a patent has, indeed, been taken out for making a colouring matter in this way, the process has, I believe, been abandoned, as it is not very practicable.

It is to Mr. W. H. Perkin that we owe entirely the first method, by which dye was obtained from tar on an industrial scale. Mr. Perkin was, at the time—in 1856—a pupil of Dr. Hofmann, and was engaged in the endeavour to form, by artificial means, the valuable medicine, quinine. I need not stop to detail here the details of this investigation, but may just say that he was acting upon a compound of toluidine with bichromate of potash. He was, as he tells us himself, surprised to find that, instead of getting quinine, he obtained only a dirty reddish-brown precipitate.

Being, however, desirous to know something more of the nature of this, he tried another base, and was fortunate enough to select aniline. I do not think that, unless Mr. Perkin had been a very persevering chemist, we should have been any nearer to coal-tar colours to-day than we were in 1856; for in this case the precipitate was of quite as unpromising appearance as the first; but when it was more carefully examined, he found it to contain a beautiful purple-colouring matter. Here was the first appearance of *mauve*. Now this action of bichromate of potash on aniline will perhaps be clearer to you if we make the experiment. Here is a solution of aniline, and we will add to it some bichromate of potash solution. This is, somewhat curiously, the very process which is even now adopted in making mauve. This dirty-greenish-black precipitate is collected, and dried; it used to be washed with coal-tar naptha, which removed a troublesome, resinous substance, with which it is contaminated; but this has been given up, and the powder is now treated at once with dilute methylated spirit, which dissolves out the dye; next the spirit is distilled off, and the dye which remains in watery solution is precipitated by the addition of caustic soda; it is then collected on a filter, washed, drained, and dried. Here is some of this

aniline purple; it is a solid mass, brittle, and has a very beautiful bronze-like lustre. We shall have to speak of this property of some of the coal-tar dyes again, so we will not stop to notice it now. Mauve is not very soluble in water, but very readily indeed in alcohol. Its intensity of colour is very remarkable, as I shall be able to show you. Here is a large vessel of water, and we will add to it some mauve, in the proportion of only $\frac{1}{10}$th of a grain to a gallon. You see, even with this small quantity, the colour is not only distinct but deep.

This beautiful colour—here is a piece of paper, on which we have fixed it by means of albumen—is so much used now that many of my hearers know, probably even better than I do, that it is one of the "fastest" of the coal dyes, bearing the action of light remarkably well.

Now we have so much before us, that, as regards the chemical constitution of mauve I must only stop to point out to you that it is really a product of the oxidation of aniline; the bichromate of potash giving its oxygen to the base, and itself becoming reduced to sesquioxide of chromium. But no sooner was it ascertained that the action did depend upon oxidation, than the patent office was flooded with specifications, in which it was sought to supplant that of Perkin by effecting the same end by different means. It would be only interesting to chemists, were I to read the list of substances which appeared in these specifications, to frame which, it would almost seem as if the text books had been ransacked for bodies capable of giving up their oxygen to aniline. Among those which we may single out, as really practicable, is the process of Dale and Caro, in which chloride of copper is used instead of bichromate of potash.

It was, however, soon discovered that, though a substance might oxidize aniline it would not necessarily produce mauve; and it was found that there were some re-agents, as, for example, nitrate of mercury, tetrachloride of carbon, chloride of tin, &c., which, instead of a purple, gave a crimson colour with aniline.

The discovery of this fact was the earliest step in the history of what is now known as magenta.

Magenta is formed when oxidizing agents of a less energetic character than chloride of lime or bichromate of potash act upon commercial aniline. I say, on commercial aniline, because it has been found that pure aniline does not give the colour at all; and it has been found that the impurity—if we may so call it—which is necessary to a successful result, is another body, the name of which we have here on the diagram, and which bears exactly the same relation to the coal-tar product toluol as aniline does to benzol. This toluidine is not put into the aniline for this purpose, but the benzol used for making aniline is selected at such a boiling point as will ensure the presence of toluol—the mixture being then first formed into a nitro-compound, and finally heated with iron and acetic acid, furnishes the mixture of aniline and toluidine which constitutes the aniline of commerce.

The process which is invariably followed in this country for the manufacture of magenta is that of Medlock. It consists in heating the aniline for some hours with a saturated solution of arsenic acid. This process is effected in a large closed iron vessel set in a furnace, and provided with a stirrer. Heat is applied, and the mass is examined from time to time, until the maximum of colour is produced. Water is then added, and steam blown into the apparatus to dissolve the crude dye. The solution is filtered, and common salt is added to it. This throws down the colouring matter, which is collected again, dissolved in hot water, and set aside to crystallize. The result is in the form of these beautiful crystals, which I owe to the kindness of Messrs. Brooke, Simpson, and Spiller.

I think I can show you the formation of magenta from aniline, if we use, instead of arsenic, another substance, which does not require so much time. Here we have some aniline, and if we mix with it a little chloride of mercury, or corrosive sublimate, it forms a somewhat thick, sticky liquid, which, as I heat it slightly, becomes, first, thicker and pasty, and then melts. As soon as it begins to boil the colour comes, and goes on increasing in intensity. It has now become very deep indeed; and you will see this better if I add some alcohol to it, and then pour a few drops into this large jar of spirit. Observe how all the liquid is coloured in a moment.

Magenta, from a chemical point of view, is a salt of a base called rosaniline; and it is a very curious thing, that, while the base is as nearly as possible colourless, the salts are colours of such intensity. Here, for example, is an ammoniacal solution of this rosaniline, and if we add to it an acid— some acetic acid—you see how rapidly it becomes red. Even the carbonic acid of the air can effect this change. So soon as the ammonia evaporates from the liquid, which I have here upon a piece of white paper, we have the crimson colour produced. Or, like most experiments, this may be pleasantly varied if we substitute this white flower for the paper, and having immersed it in the solution, warm it gently over the gas flame. See how quickly the rose of York becomes that of Lancaster. It has been shown by Dr. Hofmann that when magenta is what chemists call reduced, that is, deprived of part of its oxygen,it is converted into this brown substance, called *leucaniline.* I must not dwell upon this, but may show you that, though acids do not, in the case of rosaniline, develope colour with this substance, it is at once transformed into rosaniline if we give it back its oxygen. Here is a solution of leucaniline, and I will add to it some bichromate of potash solution, which is a very convenient way of getting oxygen into bodies. As we heat the mixture, you will observe the red colour of magenta is at once developed.

You are all as familiar as I am with the colour of magenta; but you see it looks very pretty here, as we have it fixed upon a surface of albumenized paper.

Magenta is now manufactured on an enormous scale, being indeed considered rather as a raw material from which other dyes are made,

than as a dye itself, though of course there is a large consumption for it in this way too. As an example of the extent of this manufacture, I may say that, in going over the works of Messrs. Brooke, Simpson, and Spiller, a few weeks since, I was informed that they make twelve tons of aniline weekly; and at the same factory I saw magenta crystallizing from a tank which contained 30,000 gallons of its solution. This was certainly the largest tank in the place, but there were some twenty others of smaller dimensions.

Now the quantity of crimson dye which is given by coal is, if we consider the question of weight only, by no means large. Here is a block of coal, which weighs 100 lbs., and here in succession are the quantities of tar, naphtha, benzol, nitrobenzol, aniline, and magenta, which the 100 lbs. of coal give. See how sudden is the transition; notice how absurdly insignificant seems the quantity of magenta given by this large mass of coal. This smallness of quantity is, however, compensated to a great extent by the marvellous intensity of the colour. I think I can give you some idea of this. You will see, in the first place, that the quantity of wool which the magenta in this bottle will dye is nearly as large as that of the coal itself. But there is a very simple way of illustrating this in a striking manner. Here are two sheets of paper. One of them has been dusted over with some magenta, in fine powder, and the other with mauve. The colour-giving substances are there, but, at least to those of you who are at a distance, they are scarcely visible. But if we direct a stream of alcohol against the paper, you will see the latent colour develope itself in a very beautiful manner.

This experiment may be varied in a charming manner. Here you have a bouquet of apparently white flowers, on which I, before the lecture, dusted some of these dyes. On projecting a stream of alcohol upon them you will see, however, that they assume tints which, though I cannot say of them that each is exactly appropriate to the flower on which it appears, are at least sufficiently pretty.

In making magenta on the large scale which I have mentioned, there are large quantities of residuary products; and as it is important that these should be made as profitable as possible, they have been, of course, examined by the manufacturer. One result of this has been the discovery of the very beautiful orange colour which we have here, and though it is known in commerce as *phosphine*, chemists will recognize it better as a salt of chrysaniline.

This dye cannot be made at will, but is invariably formed in making magenta, and is separated during its purification. It gives, as you see, a very beautiful yellow orange tint, and is much used to produce scarlets, by first dyeing the silk or wool in magenta, and then passing it through a bath of phosphine.

Here is also a brown, which is one of these residual colours.

I spoke just now of magenta as being a raw material from which other dyes were produced, and we will now proceed to examine some of the means by which it is made to give blues and violets, and even

greens. The most important process for making blues is that in which the magenta is heated with a further quantity of aniline. The process takes some time, and the mixture, which first becomes purple, changes finally to a very beautiful blue. This is what is known as "*bleu de Lyon.*" It is, unfortunately, not soluble in water, and several methods have been adopted to make it so. The one most usually employed is exactly like that which is used with indigo for the same purpose, namely, treatment with sulphuric acid. A sulpho-acid is formed, and the result is a blue completely soluble in water. Here is a solution of this blue, the tint of which is very beautiful.

But, perhaps. the most interesting of the aniline blues is that called "Nicholson's blue." I cannot tell you how this is prepared, as the process has not been made the subject of a patent, but I can show you the blue itself. It is perfectly soluble in water, and what is most curious is, that, like salts of rosaniline, it is almost completely decolorized by alkalies. I have here an alkaline solution of this colouring matter which has been prepared before the lecture, and we will immerse this skein of silk in it, and then wash it well with water. If, now, we put the silk into water containing a little sulphuric acid, you will see the blue developed at once. This process of dying blue is now very extensively employed.

The fact that the combination of aniline with magenta gave rise to violets and blues, led Dr. Hofmann to suppose that other bodies might supply the place of the aniline. He found that this was actually the case, and that the bodies known to chemists as iodide of ethyl and iodide of methyl could be substituted for aniline, with most successful results. This discovery has given rise to an entirely new series of colours, known in trade as "Hofmann's." The iodide of ethyl, or of methyl, is heated with the magenta, just as in the case of the aniline, and this beautiful violet is the first result. The tint obtained much depends upon the quantity of iodide used; becoming bluer, and even greener, as it is in excess. Perhaps the most interesting point in this process is, however, that, if the quantity of iodide of ethyl is properly proportioned, a most beautiful green is the result. Here we have it in solution, and here is paper dyed in it. I think this is one of the most beautiful and most natural colours in the whole coal tar series, though, where all are so beautiful, it is difficult to assign the place of honour to any one. The great advantage of this green is that it is at least as beautiful a colour by gaslight as by daylight. But it has the most remarkable property of being changed by exposure to heat. It differs, as I said, from the violet dyes only in containing more iodide of ethyl than they do. But this excess of iodide can be removed by heat; and if we pass this piece of paper, which has some of the green dye on it, over the flame of the lamp you will see an almost immediate change to violet. The degree of heat required is so near to that which chars the paper, that I do not think this need be alarming to ladies who

sit too near the fire. It might, however, be made the means of securing a charming variety in costume.

When I tell you that from the final residuum from these manufactures, when all the colour has been got out, especially from Dale's process for making violet, a very intense black is obtained, you will have formed some idea of the capability of aniline as a dye-producing material. This black is used largely in the manufacture of printing ink.

But we must now pass to the consideration of some of the other coal tar constituents which produce colour, and I regret that our time is so short that we cannot speak of them, except in the briefest manner. The first of these which we shall notice is *phenol*. Here is a beautiful specimen of this body, which I owe to the kindness of Dr. Calvert of Manchester, who is the manufacturer of it in all the forms in which we find it in common. To you it is perhaps more familiar as *carbolic acid*, and its use as a disinfectant and as a remedy for toothache are sufficiently well known. We have only now to consider it as a producer of colour. At the beginning of this lecture I showed you the colour produced by phenol itself when a solution of chloride of iron is added to it. Had we time for the experiments we should find that this colour-giving property is shared by almost every compound of this body. One of the most interesting of these is *rosolic acid*. This body is procured by heating phenol with a mixture of sulphuric and oxalic acids. In commerce it is known as *aurine*. You see it here, in the fine specimen which Dr. Calvert has sent me, as a resinous mass having a greenish metallic lustre. When this substance is heated with ammonia it forms a very intensely coloured compound, which you will see produced when we add ammonia to the powdered acid in this dish. Aurine is used for dyeing this orange tint on silk, of which we have a specimen here. But if instead of merely adding the ammonia it is heated with rosolic acid in a closed vessel under pressure, there is found a new substance known as *peonine*, which was lately very extensively, and is still, I believe, to some extent used as a dye for woollens. I ought here to mention that this dye has been said to have a specifically poisonous action, and to produce blistering where the fabrics dyed with it were worn next the skin. It is, however, easily recognized, Dr. Calvert tells me, by the bleaching action exercised on it by a solution of sulphurous acid. When peonine is heated with aniline, it is converted into the blue colour called "azuline," which at one time was manufactured on a very large scale, but has now been replaced by the blues I have already brought before you.

Then when phenol is heated with nitric acid a very violent action takes place, and the body called *carbazotic* or *picric* acid is produced. This body forms very beautiful crystals, and is much used in dyeing the beautiful yellow shade of which we have an example here, and also in giving green shades when combined with the blue colours. Picric acid, in its turn, gives with cyanide of potassium a crimson dye which, when converted into an ammonia salt, is identical with the beautiful colouring matter called *murexide*, a colour formerly obtained from animal sources.

Next we pass to *naphthaline*, a substance which is a positive trouble to gas manufacturers, and in choking up the mains becomes a fruitful source of that discontent which all of us express at one time or another in reference to our gas supply.

Naphthaline, too, has been made to give colours; and though I am passing over a subject which would afford material for at least an entire lecture, I can only call your attention to two colouring matters derived from it. One of these is called "Manchester yellow," and is much used in colouring soap; the other is a *naphthaline brown*. For specimens of both of these colours, I am indebted to the kindness of Messrs. Roberts, Dale, and Co., of Manchester, who are manufacturers of them.

One of the most cherished aims of those who have experimented on the products of the destructive distillation of coal has been the production from some of them of the colouring matter of *madder*. Some idea of the importance of this problem may be gathered from the fact that the total growth of this plant is estimated to amount to 47,500 tons, having a value of £2,150,000. England alone pays no less than £100,000 annually for the madder, with which are produced the red, purple, and black printed calicoes for which she has become famous. All this money is paid to foreign countries, for England does not cultivate madder. But if we have not madder of our own, we possess coal, and every new use we can make of this becomes a new source of wealth. It is known that all the various tints, which, with different mordants, are given by madder, are due to a substance called *alizarine*. Now it was discovered so recently as last year that this body, *anthracene*, which you see here as a coal product, and a specimen of which I hold in my hand, is capable, when treated in a suitable manner, of giving a colouring substance which is in every respect the same as the alizarine of madder. I regret exceedingly that we cannot now go into the details of this subject, but I introduce it to your notice because a lecture on the coloured derivatives of coal-tar would be wanting in the last and most interesting link which has been added to the subject, were it to be altogether omitted.

I may, however, just say that this discovery is due to two German chemists, Messrs. Graebe and Liebermann, and that the manufacture of artificial alizarine is being carried on both by them in Germany, and by Mr. Perkin in England. Mr. Perkin has made a most important step in the industrial application of the discovery, for he has recently taken out a new patent in which is made a very important modification of the original process, which was too expensive to be of real commercial importance. It is interesting to find Mr. Perkin in 1856 the pioneer of the entire industry of the coal-tar colours, and now in 1870 intimately connected with that which will yet most probably prove to be the most important discovery which has yet been made in connexion with it.

I may say, too, that at present there is a difficulty in the way of the application of this means of making alizarine, and this is the com-

parative scarcity of anthracene itself. Two thousand tons of coal give only one ton of anthracene; and until this quantity can be increased either by improved methods of operation, or until some other product of coal-tar—naphthaline, perhaps—can be converted into anthracene, the production of artificial alizarine will not attain to that commercial importance which is certainly in store for it.

I will now endeavour to show you how readily the dyes from coal tar attach themselves to silk and wool, and thus illustrate experimentally the very simple process of dyeing with them. For silk and wool no mordants are used, as the affinity of these substances for the colours is very great.

Here are solutions of *magenta*, of *Hofmann's violet*, and of *picric acid*, and you see we have only to pass the skeins through them in order to dye them in a moment. But the colours do not possess this affinity for linen or cotton. I can show you this, I think. Here I have a pattern embroidered in silk on a cotton ground, and if we pass this through a solution of magenta you see it becomes uniformly coloured. But if we now leave it for a few minutes in dilute ammonia you will see that the dye is nearly removed from the linen, while the silk retains a beautifully deep tint.

You will naturally inquire how then the coal-tar dyes are applied to linen and cotton fabrics. Sometimes they are mordanted with tannin, which has the property of fixing the dye; but the usual plan is to print the colour in combination with white of egg—albumen—and then to coagulate the mixture by heat. Here is an egg which we have boiled hard, and if we put it into this warm solution of magenta, you will get a very good idea of the affinity of these colours for albumen. Now, you see it has become completely dyed. The consumption of albumen for this purpose is enormous, and is said to amount in one French province alone, where these dyeing and printing operations are carried on, to 300,000 pounds weight a year.

The coal-tar dyes have received many other applications besides those to dyeing and printing articles of wearing apparel. They have been employed to colour starch, and muslin stiffened with those starches looks very pretty indeed; they have been made the bases of printing and lithographic inks; are largely used in paper-staining; they are also employed in making coloured writing inks. Naphthaline yellow is used in giving a yellow tint to fancy soaps. Lastly, I may say that travellers have found rosaniline replacing rouge and henna on the cheeks and nails of Eastern ladies.

Before I leave a subject which has insensibly drawn me on much further than I intended, I must ask your attention to the beautiful bronze-like reflection which some of the aniline colours possess.

This appearance is common to all of them, to a greater or less extent; but I think the one which has it in the greatest intensity is the Hofmann violet.

Here is a large sheet of glass, over which we have spread some of this colour, which you see is of a most lovely purple by transmitted

light, but reflects a tint like that of some varieties of tropical beetles, or the tail feathers of the peacock. This fact has of course not escaped attention, and has been used in the decoration of several kinds of leather goods, of straw hats, and even of articles made of iron and steel. It is interesting to notice that the reflected colour is exactly the complementary of the colour transmitted.

It is not easy to obtain statistics of a manufacture like this of the coal-tar colours. I have already given you a few figures in reference to magenta, and to these I may now add, that the united gas works of Europe are capable of furnishing 53,000 cwts. of magenta, and that the estimated value of all the tar dyes made is about a million and a quarter pounds sterling annually.

You will see from the series of colours we have arranged here, that this black coal acts, so to speak, the part of a prism, and gives tints which extend from one end of the spectrum to the other; and, indeed, almost approach in brilliancy the natural spectrum.

It was once said of a celebrated divine, that he not only exhausted his subject, but his hearers too; and as I do not wish you to say this of me, I will detain you no longer. There was an old story about a farthing's worth of iron, which, when made into chronometer springs, became worth a thousand pounds. In the industry we have been considering, we have a parallel to this. Dirt has been well defined as "matter in the wrong place." This is just what coal-tar was before the discovery of these colours. When it could be made into mauve and magenta, it soon got into its right place, and has become a new means of employing labour, and a new source of wealth; for the almost useless tar gave a dye which, at the time of its discovery (it is cheaper now) sold, if not for its weight in gold, at the price of platinum.

I am painfully conscious of the imperfection of my attempt to lay before you this subject as I could have wished, but I cannot conclude without pointing out that these discoveries have arisen entirely from results obtained—not in trying to make dyes, but in studying chemistry for chemistry's sake. Hofmann, Perkin, Nicholson—all those whose names are intimately connected with the manufacture of colours from coal-tar—were students of pure chemistry. And tracing back from this large industry, which is slowly, but surely, changing the position of England from that of a colour-importing to that of a colour-exporting country, we come upon the name of him who, in discovering benzol, became the parent of it all. And it cannot be without encouragement to the student to note that the earnest study of Nature alone raised the bookbinder's apprentice to the high position which FARADAY occupied as a philosopher and teacher; that if Nature is in this respect like death,

"Pulsat æquo pede pauperum tabernas regumque turres,"

and confers her favours alike on rich and poor, she yet is the truest type of perpetual life; that Faradays yet to come may, while sitting at her feet, and

"Nourishing a youth sublime
With the fairy-tales of science and the long results of time,"

look forward, like him whom we have lost, to the period when, to use the language of an elegant writer, "the sun of truth will arise in unclouded brilliancy, and place them in the enjoyment of that intellectual light which has ever been among the holiest aspirations of the human race."

III.—*Atmospheric Dust.* A Lecture by CHARLES R. C. TICHBORNE, F. C. S., M. R. I. A.; Chemist to the Apothecaries' Hall of Ireland, &c.

[Delivered on Saturday, May 14, 1870.]

THE subject of dust is one which, although it may appear trifling to a superficial observer, is of immense importance when we consider its physiological and sanitary bearing.

It is one of those subjects that, like our knowledge of "potable" or drinking waters, has only unfolded itself within the last few years. Unconsciously, and I may say almost imperceptibly, we have been quickened to the importance of the question.

Dust is always floating—probably in very small quantities during rain, or immediately afterwards; but for all practical purposes we may consider its presence as a natural condition of the habitable parts of the world. There may be some who will say—"If our forefathers breathed such dust before us, and yet lived and died in the ordinary course of events, as we shall do in the generations to come, in spite of this dust, of what importance is it to the world at large to build up theories, and to harass our minds about such hidden matters? It may be of interest to the scientific man, but it is of no import to the world at large." Such people may easily be answered. For when the nature and quality of this dust alter with the local condition of the place that gives rise to it; when every change of temperature is capable of producing a radical alteration in the dust itself; when most of the miasmatic diseases, if they do not enter the circulation as dust, enter with it, cheek by jowl; when trades are found that have their own peculiar dusts, that in many cases shorten life, then does it not behove man to make a study of this subtile substance, not to be frightened by an invisible bugbear, but to know something about this thing that he has to do with, and to know when it may be counted harmless and when an enemy?

By atmospheric dust we mean those very fine particles which are everywhere, and are imperceptible to the eye except under exceptionable circumstances—not the heavy dust of the soil, that may be blown up by every fitful gust; but it is the dust that Bacon speaks of as "the little motes that in the sun do ever stir, though there be no wind."

We have, I dare say, all of us observed the little golden and silver particles which are rendered evident by the beam of the strong sunlight—such particles as we shall have to show you presently with the aid of another very strong light—the electric.

It will perhaps be desirable, in the first instance, to consider how this dust is capable of affecting the human body. I am very anxious to trench as little as possible into sciences of which I am merely an amateur; but it is absolutely necessary, in a popular lecture upon this subject, that I should for a moment consider the organs of inspiration and expiration, or rather I should say the chief—the lungs.

The human body may be said to have two primary organs for the assimilation of food—one the stomach, and the other the lungs—the first for the assimilation of solid and liquid substances, the second for the assimilation of gaseous substances. The lungs may be briefly described as a beautiful mechanical sponge, intended to bring the atmospheric oxygen into contact with the blood. It is in this organ that the oxygen combines with, and is carried by the blood through the body, generating in its progress the so-called animal heat, helping to build up and to pull down, and to form the numerous organic compounds so essential to the working of our economy.*

How excellently has Holmes described this organ and its functions:

> "The smooth soft air, with pulse-like waves,
> Flows murmuring through its hidden caves,
> Whose streams of brightening purple rush,
> Fired with a new and livelier blush;
> While all their burden of decay
> The ebbing current steals away,
> And red with nature's flame they start
> From the warm fountains of the heart."

"While all their burthen of decay, the ebbing current steals away," that is, the blood brings back a large part of the waste products of the body. As the lungs are the main organs for the absorption of the substances in the vaporous condition, so they are the main organs for the elimination of substances in the gaseous form. Oxygen, a substance absolutely essential to our existence, is absorbed through the lungs, whilst water and carbonic acid, and a small proportion of ammonia, are the chief exhalation.

We get our supply of oxygen from the air, and in its combination with other elements which it finds presented to it in our body produces those numerous chemical changes which constitute our existence. It is the *primum mobile*, or mainspring of our life.

The oxygen, when in the body, combines with the hydrogen and carbon presented to it, and gives rise to the animal heat, so well known to you all. The animal heat is due to a very slow, but still a perfect combustion. I have here in this cylinder a mixture of hydrogen and oxygen. I would wish you to observe that the cylinder is quite dry, the gases having been collected over mercury, they are now merely two colourless gases, mechanically mixed, but on applying a light the two

---

* A section of the human lung, the arteries injected red, and the veins blue, was projected on to a screen by the electric light.

combine, with an explosion, to form water. The aqueous vapour formed is condensed on the surface of the cylinder as dew.

Experiment.—A mixture of hydrogen and oxygen was exploded in a dry glass cylinder.

Exactly a similar combustion is going on in our bodies, only gradually, not with explosive violence, but still sufficiently strong and energetic in its action to keep up a temperature of 100 degrees, Fahr. or about 40° degrees above the temperature of the surrounding atmosphere.

I shall now place in the centre of this spherical mirror a freezing mixture, and shall suspend it from the ceiling. There is no doubt that by this means I shall be able to collect the hydrogen that you are burning in your bodies, and pouring out of your lungs on its surface in the form of dew. In a short time some drops will collect.

Experiment.—A freezing mixture was placed in the interior of a silvered sphere, suspended from the ceiling.

Now I will take you on with me to consider another experiment. In this bell glass I will introduce a piece of lighted charcoal. The bell glass has been previously filled with pure oxygen (you must bear in mind that it is diluted and weakened in all its effects as we meet with it in the atmosphere). You see how brilliantly it burns; the product is what is familiarly known as carbonic acid; you cannot see it, because it is a colourless gas; but by applying a test, which we have here in this baryta water, we get an indication of its presence at once. The white substance is formed by the combination of the baryta which we had in solution with the invisible gas.

Experiment.—A piece of charcoal was burned in oxygen and baryta water introduced into the bell jar.

If I now pass the breath from my lungs through another quantity of this clear baryta water, I shall very soon get an indication that the same process is going on in my body, and that the oxygen absorbed in the lungs is slowly burning the carbon in the body, and producing carbonic acid; the evidence is here, in this white precipitate of carbonate of barinum, which is collected from my lungs.

Experiment.—The lecturer passed his breath for some time through baryta water.

We are so accustomed to talk of carbonic acid and water as the exhalations of the lungs, that there is a popular error which imagines that these are the only two products: such, however, is not the fact.

It would seem from recent investigations that ammonia is always present, and that it is only conspicuous in its absence during certain diseases; therefore we can come to no other conclusion than that ammonia is as constant an exhalation as the other two gases. This can be rendered evident by passing the breath for some considerable time through a very delicate test that we have for ammonia; it is called Nessler's test. In such an experiment the test shows a very slow, but a gradual darkening. It would be a waste of time to try this experiment here, because it would occupy too long a time in performing, and would only be percep-

tible to those in the immediate vicinity of the lecturer. I will, therefore, content myself in showing you the action of ammonia upon this solution, which goes by the name of Nessler's test. I have a glass of it here; and by merely inverting this beaker, first over an open bottle of ammonia, and then over the glass of test solution, you will observe that the air is sufficiently contaminated with ammonia to produce a marked change.

Experiment.—A beaker was first held over the mouth of a bottle of ammonia, and then inserted over an open glass of Nessler's test.

Many other effete products are thus given off from the lungs, but in quantities so small that it is difficult to say much about them.

Dr. Angus Smith, and other authorities, have worked assiduously at this part of our subject, and yet there is a great deal to be done.

It is, however, more with the ingesta that we have now to do. That substances other than permanent gases are readily absorbed through the capillaries of the lungs, and are instantly carried through the body by the aid of the blood, there can be no doubt. If a whiff of æther is taken into the lungs, you would almost immediately feel a peculiar dryness of the skin, particularly in the palms of the hands. The smell of æther will be perceived off the body for hours afterwards, and this will be particularly the case if methylated æther (an impure kind which has a peculiar smell of its own) be used. Now, it is evident that in such a case the æther is being carried by the blood through the body, and that the superfluous amount, or what escapes decomposition in the body, is being eliminated through the skin. There is another liquid, called nitrite of amyl, a whiff of which will increase the heart's action to such an extent that a person feeling the pulse can instantly tell when the vapour enters the lungs. It may be said that the inhaling of a volatile fluid is tantamount to the absorption of permanent gases, and does not bear upon the absorption of solids, or non-volatile liquids; but I hope shortly to be able to demonstrate, by a series of experiments I am now performing, that this absorption of non-volatile matter in the lungs is a fact. The experiments, besides being incomplete, would be out of place if introduced in the present lecture. Suffice it to say that they are attended with some considerable trouble, because of the difficulty of introducing solid substances into the lungs.

The passage of gases and solids in solution into the blood through the substance of the capillary tubes in the lungs is easily explained.

The experiment upon the table will illustrate the mode by which gases enter into the blood. The experiment simply consists of a beaker, the mouth of which has been tied over with a piece of animal membrane, which will, in a coarse manner, represent the material with which the capillary vessels are formed. This beaker was placed under the bell glass some few days ago as you see it now, the bell glass being filled with carbonic acid, which, you will remember, is one of the gases given off by the lungs. You will observe that the membrane, which was originally tied on very loosely, is now almost distended to bursting. I have placed a beaker tied over in exactly the same manner, but

which has not been submitted to an atmosphere of carbonic acid, for comparison.

[Specimens illustrating the above experiment were shown.]

In this experiment a general law is illustrated, which is, that gases, in passing through a porous membrane, have different rates of diffusibility; or, to put it in another way, the gases pass through the diaphragm with different rapidities. In the experiment before you, I had two different gases separated by a porous animal membrane; in the beaker there was atmospheric air; outside, or in the bell glass, there was carbonic acid. Now, both gases passed through the membrane, but the carbonic acid passed into the beaker much faster than the atmospheric air passed out of it; it, therefore, accumulated in the small vessel to such an extent as to produce the remarkable distention that we have observed.

Liquids in the same manner have different rates of diffusibility—that is to say, some substance termed crystalloids pass through animal membranes very rapidly. Here is another experiment that will illustrate this class of phenomena, which is called osmos, or liquid diffusion. I have a vessel which I will fill with a coloured liquid solution, so as to render it evident to your sense of sight: you may view it as a bottle, the bottom of which is a piece of membrane similar to that used in the first experiment—the other end is a long tube. Now, I shall place the whole in a vessel of water, and you will observe that after a short time the coloured liquid will gradually rise up the tube, contrary to the natural laws of gravity. The explanation I have to give is the same as that given as regards the gas. The water in the outer vessel passes through the membrane, not because there are any holes in the diaphragm, but because the tissues that form the membrane have an affinity for the water, and absorb it at the surface, where it has actual contact; it is diffused through its substance to the other side, where it comes in contact again with a liquid which has an affinity for water, and which takes it up, there being an unlimited supply of water to fill its place; thus a current, as it were, is set up through the diaphragm. Now, the red liquid in the interior is alcohol, that passes through the membrane also; but the current that is set up in this opposite direction is not so powerful, simply because the membrane has not the attraction for the alcohol that it has for the water; thus, the passage in of the water being much more rapid than the passage out of the alcohol, the liquid accumulates in the interior vessel, and marks this accumulation by its rise in the tube.

Experiment.—A diffusion apparatus, charged with an alcoholic solution of magenta, was placed in a beaker of water.

We thus see that, to have absorption in the lungs, it is not absolutely necessary to have the bodies in a gaseous state; and that, therefore, it depends more upon the chemical quality of the substances passed into that organ than their physical condition.

I am now merely considering atmospheric dust from a chemist's point of view; for, although in extreme and extraordinary cases it may

get into the lungs in such a quantity as to act mechanically, in our ordinary life it is not so. The coarser particles are deposited in the mucus passages leading to those parts, and the lungs are also protected by the epithelium cilia; but that the finer atmospheric dust does enter and leave the lungs, is capable of demonstration.

Bishop Berkeley, Bacon, and other old writers, had noticed and speculated upon the motes that float in the air; but it has never been clearly brought before the public until the late experiments of Professor Tyndall, who has opened up this subject with his usual felicity. It is a simple illustration of how a well-known fact may be shaped into form and refined by passing through the crucible of a master of his science.

By atmospheric dust, then, the particles are specified which are imperceptible to the ordinary sight, but which are always floating at a certain altitude.

A strong beam of sun, or other light, reveals them, by the irregular dispersion of that light by the solid particles. To show you how easily light solid particles are disseminated through the air, here is a Bunsen burner; it is merely an arrangement by which we can burn a mixture of gas and air, and from such a burner we get a nearly non-luminous flame. It would be even less luminous but for the atmospheric dust; for all the carbon, or solid particles of the gas, are consumed as quickly as they are eliminated. You will observe that by striking the table with this old book out of the library I can at once increase the luminosity, by raising a fine cloud of dust from within its pages.

[The Bunsen burner was lighted, and on striking the table with the book the burner immediately gave a yellow luminous flame.]

Now, the peculiar appearance of the flame is due to the metal sodium, which is present in almost everything with which we have to do. It is present as the compound with chlorine, chloride of sodium, or common salt. It was not until the spectroscope (that instrument of which you have heard so much in this theatre lately) came into use that this sodium was found to be a constant ingredient of our atmosphere—that is to say, we cannot examine any flame with the spectroscope but what we shall find the specific marks or tests for sodium present. This is not due to the flame, for all flame gives it when burning in atmospheric air, but it is due to the dust which falls into the flame. As Professor Tyndall happily expresses it, these light particles of dust act as the rafts to carry about the sodium. The presence of sodium is known by a yellow line or lines appearing in the yellow part of the spectrum. I will project the spectrum of the Bunsen flame on the screen, and, although the line is not very distinct, it can be traced. It is only present in very small quantities, probably less than $\frac{1}{3000000}$ of a millegramme in a c. c. of air.

Experiment.—The sodium spectrum was thrown upon the screen.

I will illustrate this a little further. In this dish of water I will now throw in some pieces of sodium. The sodium is the metallic part of soda, which you all know. The metal has so great an affinity for oxygen,

that when I throw it into the water it tears it away from the water, which, you will remember, is formed of oxygen and hydrogen. It forms therewith the oxide, or soda, and liberates hydrogen gas, the action being at the same time so energetic that we get a combustion of the latter; but the hydrogen is burning amidst the vapour of sodium, and thus you have the characteristic yellow flame beautifully shown.

The following equation represents the reaction :—

$$\left.\begin{matrix} H \\ H \end{matrix}\right\} O + Na = \left.\begin{matrix} Na \\ H \end{matrix}\right\} O + H$$

Water. Sodium. Hydrate of Sodium. Hydrogen.

Experiment.—Sodium was thrown on to gum water.

And now I would wish you to observe that the Bunsen burner is burning with a bright yellow flame, although at the other end of the theatre, some distance from the burning sodium. The spectrum now shows the yellow flame vividly. The colour does not, however, immediately appear: it is only after a few seconds, and when the condensed particles of sodium vapour begin to fall, that we get the yellow flame. The vapour is not volatile, but is carried mechanically. This experiment will illustrate how these non-volatile particles may be carried on the organic rafts floating in the air. It will be some considerable time before the spectroscope even shows a subsidence of the solid particles of soda, of which this room is now full. You are now breathing this sodium into your lungs; but, as it is not a deleterious substance in such quantities, you need not be alarmed.

I will now pass across the theatre a beam of the electric light; and, if you will look attentively, you will observe the particles of dust floating therein. It is not always the most flashy experiment that is the most instructive. I have no doubt that many of you have seen the electric light before, but have passed unheeded by the many curious things it reveals; therefore I do not think you will grudge the credit that is due to a great man for thinking for you. If this suspended atmospheric dust was known, it was not until Professor Tyndall and one or two others, clever men, had put their stamp upon it, that its organic character, and many other points in connexion with it, were elicited and placed on record as established facts.

One of the points which Professor Tyndall has established is, that this atmospheric dust is almost entirely of organic origin, which fact is easily and beautifully illustrated by experiment. I will pass a beam of electric light down this glass tube. Tyndall calls this his experimental tube, and originally used it for other purposes than those I am now about to describe. You will observe that the beam of light is perpetuated through the whole length of the tube, simply because the tube is filled with atmospheric dust contained in the air. This tube is closed at the two ends by plates of glass: whilst at one end there is an arrangement by which we can exhaust the air, the other is connected with a platinum tube, which we can heat red-hot. Now, you will observe that, as the air is drawn out of the tube, it is replaced by air which has

to pass through the platinum, which gets hotter and hotter. The tube first gradually fills with clouds—what are they? The clouds are produced from the imperfect combustion of the organic matter that constitutes the atmospheric dust; but as this organic matter is destroyed, darkness gradually fills the tube. The dust is all burnt, and there are no solid particles for the light to infringe upon. The tube is, as Tyndall calls it, "optically empty." Now, here is an important, valuable, and beautiful experiment—no fireworks, but something even more instructive in the darkness.

The combustion may be also illustrated by simply holding a Bunsen burner beneath the beam, when coils and wreaths of what would appear to be dense black smoke will be observed; but it is not smoke, but the stream of clear air rising through the pencil of lighted dust. That this is *not* smoke, the following experiment will illustrate:—If the Bunsen burner is placed beneath the beam, and a second beam of strong light be thrown across the first one, an image of the waves of heated air rising in fanciful convolutions may be easily traced upon the screen; but although the movement of the air can be thus easily traced, all is seen to be perfectly transparent. Such is not the case, however, if we introduce a piece of burning brown paper in the field, the smoke of which immediately appears in inky distinctness from the opacity of the particles of carbon of which it is composed.

[The experiments, as detailed, were performed.]

Having demonstrated that the ordinary atmosphere is filled with organic dust, it will be necessary to show you that the quantity and quality may vary considerably according to the locality. It is self-evident as regards the quantity, that, in spite of the extreme lightness of these particles, they will gradually subside and settle down, and a pure atmosphere, as regards motes, is attainable. Even in the country, however, we find these motes. There may, besides, be organic particles even too fine for the highest powers of our microscope, or the analysis of a beam of sunlight.

It, however, requires the constant regurgitation of the waves of air, from the movements of a busy city or shifting winds, to keep this dust suspended.

I have here a flask which has been placed all night in the vaults of St. Michan's Church. These vaults possess great interest to me, as they are old friends of mine.* The vaults are so dry, and absorb moisture so rapidly, that all the bodies that are placed in them are converted into natural mummies. There are specimens, centuries old, that are as perfect as the day they were placed there, except that the flesh is converted into parchment.

In these subterranean vaults there is a long passage, closed by an iron door; and when this passage is closed, there is nothing but the still-

* Naturally formed mummies.—"Pall Mall Gazette," September 6, 1866.

ness of death. What could be more appropriate for an experiment? This flask which we have here was first exhausted, and then opened in an inverted position in the vaults. After some time it was removed, taking the precaution, however, to close it before it was removed. On placing this across the course of the light, it is found to be optically empty; it contains no dust, although it had been in a place where everything was dry and dusty; but the air was perfectly still, and all the motes had subsided; thus we see that, by merely placing a flask that has been opened in a certain locality across the beam of light, we can optically analyze it.

[A flask was shown, illustrating the subsidence of atmospheric dust in perfect stillness.]

Again, as we ascend, there is less and less of this dust. On the high mountains, such as the Alps, the air is found to be nearly pure.

We now come to a very important part—namely, the composition of this dust. The composition will differ much according to the locality; but large cities interest us most, both from the fact that the dust abounds in such localities, and because it comes in contact with more lungs. In such cities the dust contains larger quantities of matter out of place (dirt) than other localities. It mainly or almost entirely consists of stable manure, in a finely comminuted condition, with germs and other products arising from the fermentation connected therewith. In 1866, the cholera year, I published analyses of the street dusts of Dublin, taken from Grafton and other streets, and drew particular attention to the importance of this subject, as bearing upon sanitary matters. Next year Dr. Letheby wrote upon the same subject, in connexion with the mud and dust of London, and also gave analyses of them. I now place before you the results of some analyses recently made for this lecture:—

GRAFTON-STREET.

Dust dried at 212 Fahrt.

Containing—

Organic matter, ...	31	per cent.
Carbon, ...	43·7	,,
Nitrogen, ...	1·07	,,

CAB STAND, NASSAU-STREET.

Containing—

Organic matter, ...	45	per cent.
Carbon, ...	57·5	,,
Nitrogen, ...	2·1	,,
Ammonia, trace.		
Nitrates, trace.		

These dusts, if left in a damp condition, after some days become alkaline, and evolve ammonia; when first procured, they are faintly acid, and contain little or no ammonia; this, however, does not always apply to cab stands, the mud and dirt of which is generally in a progressed state of decomposition; they are most mischievous spots, and require a great deal of supervision. This disagreeable matter is all well ground down by the wheels of the cabs on the paving stones. If we take into consideration the fact that, over Carlisle Bridge alone we have a milling power that would grind many barrels of corn *per diem*, we see how well this organic matter is prepared to work mischief, if it is capable of doing so. The street dust becomes the pabulum, or stock in trade, of the atmospheric dust; and when we consider the large amount of animal matter of the worst description that is spread out for the play of the breezes, the quality of the organic matter of our atmosphere can be well appreciated. That the great supply of this organic matter is gotten from the street dust, is borne out by the microscopic and other researches of Dr. Angus Smith.* These floating particles may be viewed as the carriers of zymotic diseases, or those started by ferments.

Disease is simply a matter of chemical change produced, in many cases, by the direct action of a ferment. M. Pasteur, proved, many years since, that if a flask of putrescible matter were closed after being filled with air that had passed through red hot tubes, we get no fermentation. Why? Professor Tyndall's experiments explain this phenomenon; the germs of fermentation contained in the air have been destroyed. M. Pasteurs had done to the air entering the flask what was done some short time since to the air entering the tube. The germs were burnt up. Here are specimens of soup and milk some two months old, and yet, when opened to-day, quite fresh and good; but the most curious part of this is the fact that they were simply closed with prepared cotton wool. Each specimen was boiled in its respective flask, to destroy any germs that might be in them, and closed whilst boiling, but now they have been once opened fermentation would set in, for the atmospheric dust would enter with the air.

---

* "On Organic Matter in the Air," by Dr. Angus Smith. Microscopic appearance and substances observed in water shaken with the air, enclosed in a bottle of a capacity of 4·99 c. c., the bottle being shaken with the same water, but refilled with air 500 times. Amongst other objects, the following are noted as the principal:—"First, observations for living organisms were noticed; but it was afterwards proved that the germs of plant and animal life were there;" "spores and sporidiæ appeared in numbers;" reticulated bodies resembling the particles so abundant in coal; "*fragments of vegetation resembling in structure hay and straw, and hay seeds*, and some extremely thin and transparent tissues showing no structure," "a few hairs and leaves of plants, and fibres similar in appearance to flax," cotton filaments," "starch," &c., &c. "For the purpose of obtaining a rough approximation of the number of spores or germs of organic matter, I measured a quantity in the pipette, and found it contained 150 drops of the size used in each examination. Now, as I have previously stated, that in each drop there were about 250,000 of these spores, and, as there were 150 drops, the sum reaches the startling number of 37½ millions.

[*Specimens* of soup and milk which had been boiled in the flasks were shown.]

One of the practical applications of these and similar experiments has been wonderfully developed by Professor Lister, of Edinburgh. To use his own words, it is a system of treatment which consists of such management of surgical cases as shall effectually prevent the occurrence of putrefaction in the parts concerned. "When this is really secured, surgery becomes something totally different from what it used to be; and injuries and diseases formerly regarded as most formidable, or even hopeless, advance quietly and surely towards recovery. Of this system, the germ theory of putrefaction is the pole star, which will guide you safely through what would otherwise be a navigation of hopeless difficulty." "The germ theory declares that the putrefaction of organic substances under atmospheric influence is not effected, as used to be supposed, by the oxygen of the air, but by living organisms developed from the germs floating in the atmosphere as constituents of its dust."* In speaking in the same lecture of these floating germs, the same author says, if a ray of sunlight were to shoot through this room, we should see the sunbeam peopled with motes to the naked eye. But the particles are gross indeed, compared with the sporules of such a fungus (capable of producing fermentation). Some of them are complicated organic structures, such as pieces of hair or vegetable fibre; and if these are suspended in the air, still more must microscopic spores be so, though their extreme minuteness makes it less easy to distinguish them from particles of inorganic matter.

Space will not permit me to go into Professor Lister's line of investigation at present; but, in conclusion, I may remark that by a careful and well-considered system of antiseptic treatment, which is based upon the scientific consideration of the germ theory, hospital gangrene, and such like diseases are said to be almost unknown in the institution with which he is connected.

As regards the dust eliminated during the different processes of trades, I have only one or two remarks to make. In most cases they act chemically, but many cases are known where they shorten life merely by the mechanical entrance of particles into the lungs. Where we find coarse and heavy particles, such as iron, and such glutinous particles as flour, passing through the protective passages into the lungs there is nothing wonderful in spores, 250,000 of which have been seen in one drop of water passing, particularly when such motes are found to pass and bubble through vessels containing sulphuric acid without being stopped.†

---

* Introductory Lecture delivered in the University of Edinburgh, November 8, 1869, by J. Lister, F. R. S., &c.

† "Two tubes were placed in succession in the path of the dust, the one containing fragments of glass, wetted with concentrated sulphuric acid, and the other with fragments of marble, wetted with a strong solution of caustic potash. To my astonishment, the germ passed through both."—Professor Tyndall in "Dust and Diseases."

The following points are selected from letters I received in reply to my queries upon this part of my subject. One letter runs as follows, and refers to the needle grinders:—"I have made inquiries, and find that there are no printed statistics published of the effects produced on human life from grinding needles. I can state, from the results of my own observations, that the lives of the needle-pointers have been prolonged at least twenty years, if not longer, by a fan having been adopted in the mills several years since, which carries away the dust through an underground shaft into the open air: the men also wear a cover over the mouth. Before the first-named precaution was adopted, however, the average lives of these men would be about thirty-five years."

"Electro-plate workers use lime in giving a 'colour' to the silvered goods in the process of 'buffing' or polishing. A man will not work at the buffing with the lime above one day in the week, and, if asked to do so, immediately gives notice."

There is a great deal of grinding in the manufacture of edge tools, and polished iron work of every description; and there are two kinds of grinders—the wet and the dry grinders; the first suffer, but not nearly so much as the latter, who "buff" or polish their goods with emery, which you know is a very hard mineral.

It is also curious to find that the polishing of cast iron is said to be much more injurious than wrought, or even steel. The sleeves of these men's shirts are a mass of iron mould from wiping the perspiration off their faces.

One intellectual man said that workmen could not afford respirators, which soon became filthy, and were very hot and uncomfortable to wear, and made them feel faint.* When told that he did not look so bad, he said that at one time he was very ill, but was much better now (aged 32). His doctor had told him he might live to about 46; his fellow-workers died about 40. He took an emetic every week. Dr. Sigerson also states that scutch mills, from the character of their spiky dust are human slaughter houses. Dr. Mapother has described an excellent respirator for working men.

Although the workman is sometimes an inconsiderate being, what does he not suffer in the cause of commerce, and how careful we should be in legislating justly and considerately for this being, who offers up as a sacrifice so many precious days of his life on the altar of mammon.

As regards the difficulty in intercepting this floating matter, Tyndall, in mentioning the subject, gives cotton wool as being the best intercepter; therefore it will be the best mechanical purifier. You must remember that when there are no particles of dust, there is no continuity of the light. The following experiment of Tyndall will illustrate this in another manner. I have here an ordinary glass shade, and I will

* Probably the most convenient respirator would be simply something in the fashion of a cigar holder, containing a little cotton wool, and the lightest possible plug of cotton wool for the nostrils, held on by wire; the act of holding the first in the lips would effectually close the mouth.

place it in the track of the beam, mouth downwards. The track can be observed passing through the shade; but if I let pure hydrogen gas enter the shade from the top downwards, this gas being much lighter than ordinary air, it gradually displaces it. Hydrogen is a metal in a gaseous state, and is the lightest substance known. As soon as it occupies the space crossed by the beam the luminous trace is obliterated. Here we have the same results, or darkness produced as when we burnt up the motes.

Experiment.—Hydrogen gas was pressed up into a gas jar until the atmospheric air was displaced, the beam at the same time passing through the shade; after some time the outline of the jar was cut out in blackness.

Having thus reminded you of the optical appearance that is produced by placing pure air or gas into the track of the beam, you will understand the experiments which illustrate the effects of cotton-wool as a fitting medium, as detailed by Professor Tyndall. "I fill my lungs with ordinary air, and breathe through a glass tube across the electric beam. The condensation of the aqueous vapour of the breath is shown by the formation of a luminous white cloud of delicate texture. It is necessary to abolish this cloud by heating this tube: when this is done, the luminous track of the beam is uninterrupted, the dust from the lungs makes good the particles displaced. But after a time an obscure disk appears upon the beam, the darkness of which increases, until finally towards the end of the expiration, the beam is, as it were, pierced by an intense black hole, in which no particles whatever can be discovered. The air, in fact, has so lodged its motes within the passages of the lungs as to render the last portions of the expired air absolutely free from suspended matter.

"I now empty my lungs as perfectly as possible, and, placing a handful of cotton wool against my mouth and nostrils, inhale through it. On expiring the air through the glass tube, its freedom from floating matter is at once manifested. From the beginning of the expiration the beam is pierced by a black aperture."

Before concluding this rather meagre account of so important a subject, I would wish to add a few words as regards the merit and bearing of the question generally. Because we have had it strikingly placed before us that we are constantly inhaling dust, we are not necessarily to work ourselves into a dust mania; but, on the other hand, we should not be callous to the danger that may arise from such a quarter.

You know, perhaps, Voltaire's remarks when he was told that coffee was a slow poison—"You are right, my friend; it is slow, and horribly slow. I have been drinking it more than seventy years, and it has not killed me yet." Well, Voltaire was a sceptical kind of a man, but we must not be too sceptical, for dust may be harmless, very slow poison, and sometimes such a poison that no human efforts could stay its power.

I remember a very clever article appearing in one of the papers some years since upon the change of matter, in which the author showed that

the number of persons who had existed upon our globe would, on calculation, be five persons to every square foot of earth; so that the earth was one vast cemetery, the whole surface of the globe having been dug over 128 times to bury its dead—that

> "There's not a dust that floats on air
> But once was living man."

Now, such a notion would not be pleasant; and, however clever such writing may be, it is but the hyperbole of science—simply a poetical license. We are not breathing the dust of our forefathers; it is changed, and is constantly changing. We are consuming oxygen, hydrogen, carbon, and other substances; but the oxygen, when it enters into my system, and combines with the products it already finds there, is no longer oxygen; its entity is destroyed, and it exists as another compound. In fact, our bodily existence on earth may be viewed as typical of the interchange of chemical molecules generally; and, whilst we are tied to these chemical atoms, let us hope that we may use them to our own honour, and to the advantage of our fellow-creatures.

IV.—*On some Recent Advances in Comparative and Homological Anatomy*. By ALEX. MACALISTER, Professor of Zoology, and Director of the Museum, University of Dublin; Honorary Professor of Anatomy, Royal Dublin Society.

[Read February 20, 1871.]

IN addressing a mixed audience I am fully aware that few subjects give so little promise of interest as Anatomy; but the cause of this unpopularity is often rather in the anatomist than in his science. In the studying of this branch of knowledge we require to be most laboriously minute, and hence are liable to dwell too long on particulars, and possibly too little on generalizations, and thus anatomical descriptions become often painfully prolix. The anatomist is too often like a miner detaching and hewing out separate stones of fact from the quarries in the world of nature, while he should rather be like an explorer of unknown regions, following the courses of masonry and the colonnades of pillars in the great temple of truth, that he may be able to describe not only their individual characters, but their relations one to another as well as to the whole of which they are a part. And, in truth, the scientific anatomist is just such an explorer introduced into an unknown region, and he has, like his prototype, the historian or archæologist, to collect the scattered facts which lie around him, to seek for Rosetta stones and other similar guides, whereby he, like another Grotefend or Champollion, may, in the first instance, frame his alphabet, and then set himself to work to decipher the inscriptions, those secrets which lie

around him hidden in every organized frame. He has to cull from these the materials for a history of the living forms which are his study.

When we enter upon our study of the details of animal form and structure we feel in relation to them as the traveller does when he views the Egyptian Pyramids, and the same questions will occur to the minds of both under these conditions. Our principle of curiosity prompts us to inquire among other things—who was the builder? why was it built? and how was such a stupendous work accomplished? *In limine,* I take it for granted that none here will question that there was a framer in the case of the body, just as no rational man could conceive of the pyramids growing without a builder, and therefore I will not delay in the consideration of this point; but granting as we all do the existence of a Creator, we are brought face to face with the other two questions, and it is the business of science to search after their correct answers. Why were these various structures built up as we find them? and how were they brought to their present condition? We need not expect to find the solutions of these questions easier in the case of the organized world than it is in the instance of the Pyramids; for if we cannot as yet with certainty unravel the history of an event which only occurred a few thousand years ago, how can we expect to interpret with ease that vastly older history which began with the dawn of creation? And if the question of the method of the building of the Pyramids be yet an enigma (even though that work must have been accomplished by the few and feeble means at man's disposal), how much greater the difficulty that besets us when we attempt to penetrate the mystery surrounding the plans of Him who, being a Creator, must have a limitless range of means at His command. Still this expected difficulty should not daunt us in this which is a legitimate pursuit, as it is one of the highest employments in which the human mind can take part, to search out the works of nature and to seek after the truths which lie hidden in them. In two directions, then, we may pursue our investigations, for we have two prominent questions to answer. We may strive to decipher the why, and thus occupy our minds with the considerations of Teleology, or confining ourselves exclusively to the question of method and order, we may endeavour to unloose the many tangled and puzzling knots of Morphology.

We may remark here that these two lines of study, though different, are by no means hostile, though their incompatibility has been too often assumed, especially by those who profess to belong to the advanced school of naturalists; but, as Professor Huxley has most admirably stated, in his Hunterian Lectures for 1869, Teleology is perfectly compatible with any of the ordinarily received theories of creation, and he who pursues the study of Anatomy from a teleological point of view, may be confident that his position as such is stable, no matter whether he be a believer in evolution or in separate specific creation. We need not delay to cite instances in illustration of this proposition, for the conclusion commends itself to us all, that an organ is no more fitted for the

fulfilment of its function when at once brought into existence as a specialized part, than when it and the necessity for the function have grown *pari passu* under the influence of external circumstances (which in themselves are the consequences of the actions of those forces which the Creator imparted to his universe at its origin, and which he sustains in operation).

Into questions of Teleology I do not intend now to enter, for they, though of the deepest interest, would lead us from the line of facts and deductions which I desire to lay before you.

The science of Morphology consists of two main divisions, the first of which deals with the structural arrangements and forms of animals, and the second with the laws of formation and the methods of development. The former branch is that which supplies us with the facts, and from these as data we reason inductively and arrive at the fundamental laws of form. In connexion with this subject it is marvellous how many questions of interest there are opened up for our study: how the form absolute of the individual is produced; what relation its parts have one to another; the relation of the forms of groups of animals one to the other; and the causes of these resemblances and the natures of their affinities.

One of the great mysteries which it is the business of morphology to elucidate, is that surrounding the origin of species, and in approaching the determination of such a vital and fundamental point in Natural Science, it behoves us to be specially particular that we are arguing on sufficient data, and that we are pursuing a logical method. Here, especially, we should suspend judgment until we have laid a solid and stable foundation of premises adequate to bear conclusions which shall withstand the storm, floods, and rain of prejudice or controversy.

One of the most necessary foundation elements upon which to build such a superstructure is the demonstration of the presence or absence of connecting links between diverse classes, intermediate forms possessing some of the characters of the class below, together with the essential distinguishing marks of the class above. That such forms in many cases are well known to exist, is easily seen from the fact, that it is almost if not altogether impossible to define any class, order, or genus in the animal kingdom so clearly and naturally as not to exclude some members which should be in it or to include some which should not. Many interesting examples of these have been recently described, some of which, like Archæopteryx, have attracted a considerable amount of attention from comparative anatomists. Now, there are two sorts of such connecting links, in some cases the intermediary characters are apparent at first sight in the structure of the adult individual, while in others we require to know the series of changes undergone by the animal in its development, some of which resemble the metamorphoses of the creatures of another class.

Of each of these sorts of intermediate organisms, examples have recently been published, and I cannot do better than direct your attention to a single illustration of the latter sort, referring in passing to the

non-tentaculated Protohydra Leuckarti, recently discovered by Dr. Greef of Bonn, in the sea-weed and diatom slime from the Ostend oyster-park, as an example of the first kind of intermediate form. The detailed description of this is to be found in "Siebold und Kölliker's Zeitschrift" for 1870, p. 36.

As an example of a connecting link, traceable in the course of the embryonic development of an individual, one of the most interesting that has hitherto been discovered, and, at the same time, one of the newest in the order of discovery, is that which bears on the relationship of embryonic form between the ascidian molluscs and the vertebrata. From the time of Lamarck the two great divisions of animals—vetebrate and invertebrate—have been recognized as severed from each other by a wide and impassable chasm. At the foot of the vertebrate series there stands a creature of great simplicity of organization—the Amphioxus lanceolatus of Yarrell; a fish with no appendicular skeleton, with no true heart, without a true brain, with no red blood corpuscles, without capacity for sight or hearing; so lowly in organization, that the zoologist, Pallas, referred it to the family of the slugs, but yet a true vertebrate, having a chorda dorsalis, a bicavitary body, one cavity being neural, and the other hæmal, essential characters in which all vertebrate animals agree. Through the researches of Retzius, Müller, Goodsir, Kowalevsky, and Owsjannikow, this creature's anatomy has been carefully made out, and its developmental changes have been traced. In 1866 Kowalevsky published in the "Memoirs of the Imperial Academy of Sciences of St. Petersburg" (VII Serie, Tom. x., No. 15), a memoir on the development of simple ascidians, in which several new and, at first sight, startling facts were disclosed. Entering into the labours of Milne-Edwards, Van Beneden, Kölliker, and Krohn, this observer has patiently and carefully watched the progress of the development of the egg of these lowly molluscoids, and has recorded and figured the transformations of which he has been a witness; the sum of which may be briefly stated thus, that there is not a character supposed to be essential to a vertebrate animal which is not possessed by the ascidian larva; and we are not now dependent alone on this single, though competent, witness, for these remarkable facts, which were foreshadowed by Krohn ("Müller's Archiv.," 1852, p. 316), and elucidated by Kowalevsky, have been confirmed by the observations of Professor Kupffer, of Kiel ("Schultze's Archiv.," 1869, and 1870).* Kowalevsky traced the development of the earlier stages in the eggs of Phallusia mammillata (Cuv.), and of the latter in the Ascidia intestinalis (Linn.). The first changes observed were such as are familiar in the development of every egg, the yolk cleaving into two, four, eight, and sixteen masses, and this division

* Since this lecture was delivered Kowalevsky has published a second memoir on the subject in Schultze's Archiv., 1871; but I saw it too late to present here an abstract of its contents.

increasing until the entire mass becomes mulberry-like, with a central cavity (cavity of Von Baer) (Fig. 2). Soon this, when viewed in transverse section, is seen to present a sulcus, which becoming deeper and deeper (Fig. 3), gradually closes, until its orifice appears as a mere linear slit (Fig. 4). After certain other changes along the dorsal border of the bilaminar embryo, thus constituted, lateral folds (Rückenwülsten) begin to rise, bordering a linear depression, and this becomes gradually deeper (Fig. 5), until the folds coalesce over it, except at the anterior end, closing in a second or neural canal, shown in the longitudinal section of the egg (Fig. 6). Here is also seen another structure—a chain of cells developed external to those at the lower dorsal part of the inner cavity wall; this "zellenstrang" projects into the hinder end of the embryo, elongates, and becomes the axis of the tail of the larva; its situation is on a plane between the visceral and neural canals. Thus it forms a rudimental notochord. And here in a simple condition we find a state of things essentially similar to that in the embryonic Amphioxus—a visceral cavity, a rudimental notochord, and a neural canal open at its anterior end, for such an opening Kowalevsky found in the embryo of the Amphioxus, and figured in his Paper on the development of that vertebrate (Taf. II., Fig. 23). The tail becomes incurved, and the larva in section assumes the form represented in Fig. 7. Then the neural cavity becomes globular; the incurvation of the tail increases, the alimentary canal gradually overtops the neural, and inclines towards that aspect of the embryo. In the intervals between the notochordal cells highly refracting bodies arise. In connexion with the neural cavity, nerve cells, and the ocular and auditory organs become developed, and thus from its vertebrate it retrogrades to its mollusc condition (Fig. 8). Further than this we need not trace it; for we have seen the principal points which concern us here, and need only add, that this resemblance to the vertebrate structure is strengthened by the observations of Professor Kupffer, who has seen the prolongation of the notochord actually between the neural and visceral cavities in the Phallusia canina, and he has described in detail the development of the nervous system, adding many valuable confirmations and additions to Kowalevsky's original work.

This is a new field opened for our study, and much valuable and significant information may be expected when such of the ascidians as the symmetrical Pelonaia are traced in their development; and it opens up to us a singular train of thought as to why ascidians should thus temporarily assume vertebrate characters while they are being developed.

But, as we have already indicated, morphology has other concerns beside the elucidation of the origin of species; and one of these, which should really come foremost in the order of consideration, is the relation of the various parts of the one animal to each other—a relation which is the foundation of the different symmetries formed in nature. This relationship varies in the different groups of animals, and no

branch of morphological study is more beautiful and interesting than that which has for its object the tracing of these symmetries, as they gradually glide from one form to the other. In the simplest of animals, the Monera, the organism being mere Cytodes, masses of non-nucleated protoplasm, no symmetry can be expected, as the mass is homogeneous and undifferentiated; but in the separately living Lepocyta, attempts at regular forms are commonly to be found ; for to this group of forms we refer such creatures as the Gromida, Lieberkühnia, and Actinphrys, singly-celled protoplasm masses, with a definite and often regularly symmetrical form. Of true cells, with wall and nucleus, most animal structures are made up in some way or other. The simple fusion of cells produces a filament, as in the Torula, primitive muscle bundle, or the primitive nerve tube. A still further degree of cell union, not linear, produces homoplastic tissues, such as the frond of Phycoceris, cartilage, epidermis, the elements in this case all undergoing a similar amount of change. If, however, some of the cellular elements become differentiated, a third degree of complexity in development is reached, and the produced organ is heteroplastic, filaments and tissues of various kinds, and for various purposes, being the result—the joints of Spirogyra, nerve-cords, bone or muscles, as the case may be. A group of similar related heteroplastic organs in any body forms a system, and a group of dissimilar heteroplastic structures associated for the performance of any one function, or set of functions, composes an apparatus. Now, in all these details of organic structure, some degree of symmetry can be traced; but we are concerned now not so much with the symmetry of the elements of the animal organs or apparatus, but with the relationships and symmetries of the animal in its entirety. Various methods of relationship may obtain between the different organs making up the individual. The whole animal may be but one organ, or these components may be radially clustered around a common centre, forming a single somatome, whose radial elements are comparable, and may be distinguished by the name of antimera (Hæckel); or a series of such groups of antimera may successionally follow each other, as metamera (Hæckel), or these definitely combined, may make up a persona, or individual (Hæckel). Now, in the persona, we may regard the various successional parts or segments as related to each other genetically in the manner of a chain of continuous buds; hence each of the metameres is similar to the others in essence, and we have reason to expect that such personæ will consist of elements which are comparable one with the other; and hence we find that in the largest number of the animals constructed on this plan, each intermediate segment is similar to its predecessor and successor; thus each somite of a crustacean is, in its elements and its appendages, similar to its neighbouring metamere, and although the parts are much more specialized in the vertebrata, yet, even in this class, a metameric relationship between the successional parts of the members of the group is traceable. On no other ground can we so easily account for the fact, that, in nearly all vertebrates there is trace-

able a serial homology between parts arranged in order from before backwards.

That such parts as the fore and hind limbs of vertebrate animals are related to each other has long been recognized; but how, or why, they should be so related, has been a vexed question which has long been a standing morphological puzzle. That this subject has given rise to much discussion, and has been frequently studied, we may infer from the fact, that at least two score papers and books have been written either directly or indirectly on it, and at least ten theories of relationship have been proposed. In no other branch of morphology has so much interest been excited as in this one point of the relationships of the limbs, and few subjects have ever been so much darkened by words without knowledge. As I have been to some extent responsible in the way of increasing the cumbrous pile of writing on the subject, and as my investigations of the past three years have led me considerably to modify the opinions, which I had previously enunciated, I think that, as an important recent advance in anatomy, I may be permitted to call your attention to the different facts which have led me to adopt a modified view on the subject, and to give in detail the view which, with my present light, I think to be most in accordance with morphological fact.

Into the question of why these appendicular processes from the middle blastodermic lamina should take certain constant forms, I will not enter, because I do not believe that we possess any positive information on this subject; at any rate I would have nothing but conjecture or hypothesis to offer, and with this I do not think it would be advisable or advantageous to occupy your time. We will, therefore, assume that there must be a reason why there should be a definite method of growth.

It were also needless for me to recount the ways by which different authors have attempted to homologate the two limbs. Suffice it to say, that most of the theories were based upon the exclusive consideration of some one fact or other. Vicq D'Azyr regarded the right arm and left leg as homologous; Cruveilhier believed that the radius and ulna represented, not the tibia and fibula respectively, but that the former of the leg bones was made up of representatives of the upper part of the ulna and the lower of the radius; while Maclise, Martens, and others, regard the humerus as representing a femur which has been twisted in the middle. The morphological mistake into which all these authors have fallen, is that of studying the homologies of already developed and specialized parts; whereas, had they devoted their attention either to embryonic structures, or the limbs in their least differentiated forms, they must have seen the fallacy of their opinions. Let us now, in comparing the fore limb with the hind, endeavour to trace them from their simplest form, that we may lay a correct foundation for a true system of special limb homologies.

The simplest form in which we find the limbs is in that of a horizontal ray projecting at right angles from the body, as in the Ichthyo-

saurus or Plesiosaurus. Here we find from the shoulder and pelvis girdles that the limb passes horizontally outward, with all its parts in the one right line. In Siredon we see a somewhat similar arrangement; but flexion of the second limb joint has commenced, and in most of the lacertians and crocodiles we find that, while the first limb-bones pass out horizontally at right angles to the vertebrate axis, the second parallel pair of bones, radius-ulna and tibia-fibula, are flexed in a similar direction on the primary bone, while the manus and pes pass, more or less, directly outwards. In Proteus anguinis we see a similar flexure attended with an additional appearance—namely, that the first joint is not only flexed, but the whole of each limb is rotated backwards through a space of several degrees. In the higher vertebrates we see another stage in development, for the whole fore limb exhibits a slight rotation backwards, while the whole hinder limb displays an opposite rotation forwards, and in the great majority of vertebrates a similar series of alterations in position occur. The result is, that in these animals the surfaces and edges of the limbs are not, in their fully developed condition, in perfect correspondence with each other. Thus the preaxial edge of the limb which contains the great toe, tibia, inner condyle, and lesser trochanter of the femur is, in the hinder limb, turned inwards in most of the mammalia and birds, while the post-axial edge is directed outwards. This latter includes the little toe, the fibula, outer femoral condyle, and greater trochanter.

Occasionally, however, we do find a specialized vertebrate hinder limb, not thus rotated, for instance, in the bats, as in *Pteropus Edwardsii*, we see that the lesser trochanter (in this case equal to the greater) is directed forwards and outwards. The flexure of the knee joint is in a backward and outward direction : the plantar aspect of the foot looks forwards and inwards, and the hallux is on the outer side of the foot, while the fibula is postero-internal, and the tibia antero-external. The difference between this limb, then, and that of the cat or other mammal, is, that in the former instance the limb has been rotated outwards, while in the latter it is rotated inwards.

In the fore limb we notice a similar set of changes; the limb of Proteus or Siredon shows the preaxial border directed forwards, and the manus directed outwards. In *Bradypus tridactylus* we notice the limb rotated backwards, while the manus, retaining its primitive position, has the fingers flexed forwards for the purposes of grasping. Putting, however, an animal of this kind on his four limbs at once demonstrates that this plan would be unsuitable for a quadruped; and as any one may prove for himself by assuming this posture, progression on the whole four limbs can only be satisfactorily accomplished by rolling the radius round the ulna until the forearm is in a condition of pronation, when the two bones are related to each other like the two strokes of the letter X; and in the elephant we find this to be the relation assumed between these two bones. In other mammals the radius becomes displaced forwards, and lies in front of the ulna; while as such motions as pronation and

supination are obviously useless in ungulates, in the majority of the hoofed animals the ulna is only present in rudiment. Thus it is that in the fore limb of a man holding his hand supine, the pre-axial margin consisting of pollex, radius, ectocondyle, and greater humeral tuberosity is directed outward (as in the bat's hind limb before quoted), while the post-axial edge is directed inwards, and the quadruped's fore limb only departs from this method of arrangement, because the antecubital portion has its pre-axial edge turned inwards by pronation. Bearing these observations in mind, we can have no difficulty in homologating the bones and muscles of the fore arm and hand to those of the hind limb, which may be done as follows:

Humerus	= Femur.
Radius	= Tibia.
Ulna	= Fibula.
Scaphoid } Lunar }	= Astragalus (Gegenbaür.
Cuneiform	= Os calcis.
Pisiform	= Sesamoid.
Trapezium	= Entocuneiform.
Trapezoid	= Mesocuneiform.
Os magnum	= Ectocuneiform.
Unciform	= Cuboid.
Pronator radii teres condyloidea . .	= Gastrocnemius externus, in part.
Pronator radii teres coronoidea . .	= Popliteus.
Flexor carpi radialis	= Gastrocnemius externus, in part.
Palmaris longus	= Plantaris.
Flexor carpi ulnaris	= Peroneus longus.
Flexor digitorum sublimis . . .	= Flexor digitorum brevis + soleus fibularis.
Flexor digitorum sublimis radial origin .	= Soleus tibialis.
Flexor digitorum profundus . . .	= Flexor pollicis longus.
Flexor pollicis longus	= Flexor digitorum longus.
Pronator quadratus	= Peroneocalcanean.
Supinator longus	= Gastrocnemius Internus.
Extensor carpi radialis longus . .	= Gastrocnemius Internus.
Extensor carpi radialis brevis . . .	= Gastrocnemius Internus
Extensor digitorum communis . . .	= Extensor digitorum longus.
Extensor minimi digiti	= Peroneus tertius.
Extensor carpi ulnaris	= Peroneus brevis.
Extensor ulnaris quinti	= Peroneus quinti.
Supinator brevis	=
Extensor ossis metacarpi pollicis . .	= Tibialis anticus.
Extensor primi internodii pollicis . .	= Extensor primiinternodii hallucis

Extensor secundi internodii hallucis .	. =	Extensor hallucis proprius.
Extensor indicis	. =	
Flexor carpi radialis brevis or radio carpeus	=	Tibialis posticus.

The consideration of the order of the muscles of the hand will be seen hereafter. The credit of the determination of these positions and their relations is due to Mr. Flower and Professor Humphry.

When we approach the homologation of the elements of the shoulder and pelvic girdles to which the limbs are attached, we find ourselves at once involved in many difficulties, and our only way of extrication is by endeavouring to get some settled points on which we may build, and from which known quantities we may proceed to the unknown. In the shoulder-girdle we have two clearly defined series, the scapular and the coracoid meeting in the vicinity of the shoulder joint, while in the pelvic girdle we have also two corresponding series, the ilium and the ischio-pubic, also meeting at the hip joint; that these are serially homologeous there cannot be the shadow of a doubt. Comparing the coracoid with the ischio-pubis, we find the latter consists of two elements, both true cartilage bones, and endosteally developed, enclosing the obturator foramen, while the former, when fully developed, as in the frog, also consists of two parts, the precoracoid and the coracoid, often separated by a fenestra, as in the frog or the ostrich. I leave out of account the clavicle, a true membrane bone, developed by parostosis, and whose representative in the hinder limb is to be looked for among fibrous structures. Now, taking the various conditions of præcoracoid and coracoid in the frog, ostrich, apteryx, ornithorhynchus, bat, and man, and contrasting them with the modification of the ischio-pubis in the same animals we arrive at the conclusion that the ischio-pubis equals the præcoraco-coracoid, and that, as they are usually developed, they have undergone no rotation from, and slight rotation in, the plane of original development.

The scapular segment is not so easily compared with the iliac, for in most of the instances which we meet with in the animal kingdom these are specialized, and hence altered from their primitive disposition. From the examination of this bone in both limbs it appears to consist of two segments, a scapular and a supra-scapular, which in the lower limbs form in most animals the ilium, and the sacral epiphysary plate. This will be seen in the human limb and in that of the frog; the scapula, or ilium proper seems to be usually a three-surfaced bone; in the former, one of these is the prescapula, the second the post-scapula, and the third the subscapular fossa. In the latter there are two or three surfaces likewise—one, the iliac fossa; a second, the dorsum ilii; and a third which lies between the ilio-pectineal line, the posterior margin of the ilium, and the margin of the greater sciatic notch, very variable in extent, and often reduced to an edge. These surfaces are separated by margins, one pre-axial, the cervical costa of the scapula, one post-axial, the axillary costa, and one spinal or external. So in the ilium there

are three edges, a pre-axial or ilio-pectineal, a post-axial or sacrosciatic, and a spinal or crest. Occasionally, as in the bird, two surfaces are fused into one in the scapula; and similarly in the ilium, the commonest appearance of the bone is that of a flat bilaminar structure.

When we bear in mind these relations of position in the segments of the limb, we come to tabulate the several homologies of the limb muscles in the following method:—

Trapezius and Deltoideus scapularis	=	Gluteus maximus.
Latissimus dorsi	=	Agitator caudæ.
Rhomboidei occipitalis, major and minor	=	Absent.
Levator anguli scapulæ	=	Quadratus lumborum.
Serratus magnus	=	Quadratus lumborum.
Omo-atlanticus (trachelo-acromial)	=	Psoas magnus.
Pectoralis major clavicularis	=	Adductor longus.
Pectoralis major sternalis	=	Gracilis.
Dorsi-epitrochlearis	=	Sartorius.
Deltoideus clavicularis	=	Pectineus.
Deltoideus acromialis	=	Tensor vaginæ femoris.
Pectoralis minor	=	Obturator externus.
Subclavius (Pectoralis avium)	=	Obturator internus.
Accessorius ad pectorali avium.	=	Gemellus superior.
Supraspinatus	=	Iliacus internus.
Infraspinatus	=	Gluteus medius.
Teres minor	=	Gluteus quartus.
Teres major	=	Pyriformis.
Subscapularis	=	Gluteus minimus.
Biceps coracoidalis	=	Biceps ischiaticus.
Biceps humeralis	=	Semitendinosus.
Biceps glenoidalis	=	Semimembranosus.
Brachialis anticus	=	Biceps femoris.
Triceps longus	=	Rectus femoris.
Triceps externus	=	Vastus internus + Cruræus.
Triceps internus	=	Vastus externus.
Anconeus externus	=	Vastus internus secundus avium.
Anconeus internus	=	Vastus externus secundus avium.
Coraco-brachialis brevis	=	Quadratus femoris.
Coraco-brachialis medius	=	Adductor brevis.
Coraco-brachialis longus	=	Adductor magnus.

It is a very natural question to ask in considering these very complex groups of muscles, why has each limb such an intricate muscle-series? but simple mechanical considerations will satisfy the inquirer that it would be impossible to fulfil the necessary conditions of function with fewer elements. If we take it as a fundamental postulate that each of the important muscles is so placed as to be able to do the

maximum amount of work consistent with its bulk in contracting, we will easily be able to understand why it is that so many factors go to make up the muscularity of a limb, and with the primitive elements of the limb before us we will find very little difficulty in tabulating the different series of muscles which such a primitive limb would require; and as every limb consists generally of the same elements more or less specialized, so the primitive limb-muscle-series may be traced through the entire of the limb-bearing vertebrate scale, altered only by varieties of development, adhesion, differentiation or suppression.

This series is given in the accompanying table:—

Symmetrical type.	Fore limb.	Hind limb.
Neuro-pre-scapular,	Rhomboideus occipitalis.	
Neuro-meso-scapul	Trapezius.	Gluteus maximus in part.
Neuro-post-scapular.	Rhomboideus major.	ibid.
Pleuro-pre-scapular.	Levator scapulæ.	Quadratus lumborum in part.
Pleuro-post-scapular.	Serratus magnus.	ibid.
Pleuro-meso-scapular.	*Omo-atlanticus.*	Psoas magnus.
Neuro-humeral.	Latissimus dorsi	*Agitator caudæ.*
Pleuro-humeral.	Teres major.	Pyriformis.
Hæmo-humeral.	Pectoralis major sternalis.	Gracilis.
Hæmo-pre-coracoid.	*Supra-clavicularis.*	Pyramidalis.
Hæmo-meso-coracoid.	*Sterno-clavicularis-anticus*	Transversus perinæi.
Hæmo-post-coracoid.	*Sterno-scapularis.*	
Pleuro-pre-coracoid.	Sterno-mastoideus.	Psoas parvus.
Pleuro-meso-coracoid.	Cleido-mastoideus.	
Pleuro-post-coracoid.	Cleido-occipitalis.	Coccygeus.
Pre-axio-scapulo-humeral.	Deltoideus acromialis.	Tensor vaginæ femoris.
Meso-axio-scapulo-humeral.	Deltoideus scapularis.	Gluteus maximus in part
Post-axio-scapulo-humeral.	Teres minor.	Gluteus quartus.
Pre-scapulo-humeral.	Supraspinatus.	Iliacus internus.
Meso-scapulo-humeral.	Infraspinatus.	Gluteus medius.
Post-scapulo-humeral.	Subscapularis.	Gluteus minimus.
Pre-coraco-humeral.	Pectoralis major clavicularis.	Adductor longus.
Meso-coraco-humeral.	Subclavius.	Obturator internus.
Post-coraco-humeral.	Pectoralis minor.	Obturator externus.
Pre-axio-coraco-humeral.	Deltoideus clavicularis.	Pectineus.
Meso-axio-coraco-humeral.	Coraco-brachialis.	Adductor brevis magnus.
Post-axio-coraco-humeral.	Coraco-brachialis brevis.	Quadratus femoris.
Scapulo-pre-axial extensor.	Dorsi-epitrochlearis.	Sartorius.
Scapulo-post-axial extensor.	Triceps longus.	Rectus femoris.
Humero-pre-axial extensor.	Triceps externus.	Vastus externus.
Humero-post-axial extensor.	Triceps internus.	Vastus internus cruræus.
Scapulo-pre-axial flexor.	Biceps coracoidalis.	Biceps longus.
Scapulo-post-axial flexor.	glenoidea.	Semimembranosus.
Humoer-pre-axial.	Brachialis anticus.	Biceps femoris.
Humero-post-axial.	Biceps humeralis.	Semitendinosus.

Nature.	Fore limb.	Hind limb.
Pre-axio-humero-radial.	Supinator longus.	Gastrocnemius internus
Post-axio-humero-radial.	Pronator teres condyloidea.	Gastrocnemius externus, in part.
Pre-ulno-radial superior.	Pronator teres coronoidea	Popliteus.
Post-ulno-radial superior.	Supinator brevis.	
Pre-ulno-radial inferior.	Pronator quadratus.	Peroneo calcaneus.
Post-ulno-radial inferior.	Extensor ossis metacarpi pollicis.	Tibialis anticus tibialis.
Dorsi-metacarpalis primus.	Extensor carpi radialis accessoria.	Tibialis anticus femoralis.
Dorsi-metacarpalis secundus.	Extensor carpi radialis longus.	Gastrocnemius internus
Dorsi-metacarpalis tertius.	Extensor carpi radialis brevis.	Ibid.
Dorsi-metacarpalis quartus.		
Dorsi-metacarpalis quintus.	Extensor carpi ulnaris.	Peroneus brevis.
Pre-metacarpalis primus.		Tibialis posticus.
Pre-metacarpalis secundus.	Flexor carpi radialis.	Gastrocnemius externus in part.
Pre-metacarpalis tertius.	Flexor carpi radialis profundus.	Tibialis posticus secundus.
Pre-metacarpalis quartus.		
Pre metacarpalis quintus.	Flexor carpi ulnaris.	Peroneus longus.
Pre-proto-phalangealis primus.		
Pre-proto-phalangealis secundus.	Lumbricales +	Musculus accesorius
Pre-proto-phalangealis tertius.	Palmaris brevis	+ lumbricales.
Pre-proto-phalangealis quartus.	or	
Pre-proto-phalangealis quintus.	*Flexor brevis digitorum.*	
Pre-meso-phalangealis primus.	Absent.	Absent.
Pre-meso-phalangealis secundus.	Flexor digitorum sublimis.	Flexor digitorum brevis.
Pre-meso-phalangealis tertius.	Ibid.	Ibid.
Pre-meso-phalangealis quartus.	Ibid.	Ibid.
Pre-meso-phalangealis quintus.	Ibid.	Ibid.
Pre-trito-phalangealis primus.	Flexor pollicis longus.	Flexor longus digitorum.
Pre-trito-phalangealis secundus.	Flexor profundus digitorum.	Flexor hallucis longus.
Pre-trito-phalangealis tertius.	Ibid.	Ibid.
Pre-trito-phalangealis quartus.	Ibid.	Ibid.
Pre-trito-phalangealis quintus.	Ibid.	Ibid.
Post-proto-phalangealis primus.		Extensor brevis pollicis.
Post-proto-phalangealis secundus.	*Extensor brevis digitorum.*	Extensor brevis digitorum.
Post-proto-phalangealis tertius.	Ibid.	Ibid.
Post-proto-phalangealis quartus.	Ibid.	Ibid.
Post-proto-phalangealis quintus.	Ibid.	Ibid.
Post-meso-phalangealis primus.	Extensor primi internodii.	Extensor secundi internodii hallucis.
Post-meso-phalangealis secundus.	Extensor indicis.	
Post-meso-phalangealis tertius.	Exterior medii digiti.	

Symmetrical type.	Fore limb.	Hind limb.
Post-meso-phalangealis quartus.	Extensor quarti digiti.	Peroneus tertius.
Post-meso-phalangealis quintus.	Auricularis.	
Post-trito-phalangealis primus.	Extensor secundi. pollicis.	Extensor hallucis longus.
Post-trito-phalangealis secundus, tertius, quartus, quintus.	Extensor digitorum longus	Extensor digitorum communis.

The short hand muscles I have not included in this table, but I have made an attempt to reduce them to symmetrical order.—(Annals of Natural History, 1868, May.)

Every one who studies Comparative Anatomy, no matter to what school of biologists he may belong, must admit that in an important sense function is the chief consideration in determining the arrangement; and although we may differ in our views as to how far fulfilment of function may be a formative factor, yet in this one essential principle all must agree. A bird's wing is an adaptation of the fore-limb for flying; and whether we regard it as specially created for the purpose, or developed by the action of external forces, yet all its parts we find contrived or modified for the one end. Now, in producing or fulfilling function in limbs, muscles, as the agents accomplishing action, will be developed or obsolescent according as their individual effect is important or not. Bones are merely the passive organs—levers used by the muscles as forces—and hence they are only secondary in importance to the sources of the force or the muscles; but bones being living, growing levers are capable of being moulded by muscular action, and hence the symmetrical primary limb form has its elements altered in each instance in this order,—the special function of the part causes, or is attended with, a special modification of the muscles, and these in turn produce their effects on the bones. Thus those evenly-running animals which require forcibly and rapidly to advance their fore-limbs have, as a rule, this accomplished, among other agencies, by the possession of a strong supra-spinatus muscle, which requires an extensive origin; and hence in such there is a comparatively deep supra-spinous fossa. To illustrate this, if we take the examples of the horse, goat, cow, lion, rhinoceros, man, as a series in which there is a variety, in this function we will not be surprised to find that the supra-spinatus is to the infra-spinatus in this group in the following ratio:—1st, $1\frac{1}{3}$; 2nd, $1\frac{1}{13}$; 5th, $1\frac{3}{5}$; 6th, $\frac{4}{5}$. But the action required is a peculiar one; it is not so much requisite to lift the humerus through an extensive arc as to move it rapidly; and consequently we find the problem to be solved by nature is, not to make a muscle with long fibres (for muscular fibres, when they act, contract through an extent directly proportional to the length), but to put into the given space the largest possible number of fibres; for it is an ascertained principle that the amount of work

done by a muscle is directly proportional to its weight, consequently two muscles of equal weight can perform the same amount of work; but if one have longer fibres than the other, it is obvious that their relations in action can be simply expressed in the form of an equation. The weights being equal, the work done by them will be equal; but the work done by them is equal to the product of the weight lifted (p), and the height to which it is raised (h). Hence in the case of the two muscles—$p, h, = p', h'$; but in the case before us, as the height to which a weight is raised varies proportionally as the length of the contracting fibre, and as by hypothesis h is greater than h', therefore p' is greater than p, the contraction of the muscle with the short fibres is capable of raising a greater weight, or is more forcible through a shorter space than that of the muscle with long fibres; and we find that Nature, by making the supra-spinatus muscle penniform, exactly enables it to perform its function to the best advantage. The biceps flexor cubiti is even a more striking example of the relation which is found to exist between structure and function; for in such animals as the primates, in which the upper limb is cephalized (to use a term introduced by Mr. Dana), the biceps consists of long straight fibres, thus being capable of lifting the forearm through an extensive arc; while in the horse and ass, where the limb becomes wholly an agent in progression, the muscle becomes penniform, and is thus suited to its function of more forcibly lifting the forearm through a smaller arc.

But at present we are rather concerned with the morphological than with the mechanical aspects of myology, and to but one group of facts will I direct your attention in conclusion. To every limb there is usually one dominant function. The muscles performing it must be placed in such a position as to render their work as effective as possible; bony arrangements must be adapted so as to suit these muscles, and the other muscles which are of subsidiary importance are thus forced to be content with positions as near their primary ones as the conditions will allow; and, sometimes when their functions are inadmissible, they disappear altogether, and the spots on the bone to which they should be attached often become obsolete; and in this we have the secret of the great variety of bony and muscular arrangements in nature. Illustrations of this are to be met with in every limb. Contrasting the human fore and hind limb we see the parts of the former with their various muscles specialized; those of the hinder with their muscles coalescent, the flexors of the carpus solidified, and the humeral condyles diminished. In the leg of the lion we see the parts adapted for a simple fore-and-aft motion of the hip-joint, and hence the pelvis is very much prolonged from before backwards, but the abductors are comparatively feeble, and the external surface of the ilium is equally narrow; the same is the case with the adductors. The bird's wing illustrates this principle; in it the great action is the rotation inwards of the humerus, which produces the downstroke of the wing; for this the sternal part of the great pectoral is the principal efficient

agent; for the attachments of this muscle the sternum is raised into a carina, and the humeral upper end expanded, and in accordance with the mechanical law established by the Rev. Professor Haughton, the glenoid cavity is placed on the perpendicular to the bisector of the angle of the muscle, and humeral insertion is brought nearly parallel to one of the sides of the triangle, the two conditions of maximum work for this action, which have been discovered by Professor Haughton. We also notice that the supports of the joint, the coracoid bones, are placed at right angles to the axis of rotation, also that the actions of abduction and adduction proper at the shoulder, protraction and retraction, are not much required, but that on the contrary freedom of motion in these directions would be elements of weakness, and hence the muscles which would accomplish this action are atrophied or absent; these are the deltoideus acromialis and scapularis, the former of which is specialized for the purpose of extending the wing membrane, and the latter is proportionally small, and has, consequently, no scapular spine for its attachment; the coraco-brachialis also is diminished, as also are the infraspinatus and trapezius, while the supraspinatus, as its function is obsolete, is entirely suppressed, and its bony region completely absent; similar examples can be adduced from every vertebrate limb.

V.—*On the Loss of a Large Screw Pine (Pandanus utilis), in the Botanic Garden, supposed to have been caused by a Parasitical Fungus (Melanconium Pandani), Levielle.* By D. MOORE, Ph. D., Director.

[Read March 20, 1871].

UNTIL lately, one of the most interesting and conspicuous plants in the large Palm-house at the Botanic Garden, Glasnevin, was a fine specimen of Screw Pine (*Pandanus utilis*). It was upwards of fifty years old, and had attained to a height of 25 feet from the ground to its uppermost branches, having a clean stem for nearly 10 feet, from which the great aerial roots protruded at different elevations on it, and grew downwards at various degrees of divergence from the stem outwards until they reached the earth in the tub in which it was planted. The plant was thus propped up and supported on all sides by its aerial roots, fully realising its vernacular name in Ceylon—viz., "Buttress Tree," as well as presenting a curious form of vegetation to the numbers of visitors who frequent the gardens.

In the spring of last year (1870), some of the lower leaves on the uppermost branches were observed to turn yellow, and gradually fall off. A short time afterwards the wood on the branch from which the leaves had dropped, became soft, and unable to support the crown of leaves; it doubled up at the soft part, and hung head downwards. Not supposing that there was anything serious the matter with the plant, the decaying branch was cut away, and the foreman planted it

as a cutting in a pot. The disease, however, spread rapidly upwards, until the cutting decayed away altogether. Another of the top branches was now observed to turn sickly as the other had done, and gradually decay, until it also doubled up and hung head downwards. It was cut away, the soft part shaved clean off to the portion of the stem which was apparently healthy, and it was also planted as a cutting, but did not succeed. A third and uppermost branch followed, in every way similar to the first two, the disease constantly appearing at the basis of the leaves lowest down on the branch, and working its way gradually upwards, one leaf after another getting sickly, turning yellow, and falling off, until at length the whole crown of leaves hung down by the branch, doubling at the soft part first attacked. It now became apparent that the plant was gradually dying off from the top downwards, though the lower branches and leaves were in excellent health. A regular examination of it was made, all partially decayed leaves removed, and the soft part of the branches which had fallen down cut clean away to the hard healthy portion. Still another branch became sickly, and decayed as the others had done. We could not account for it in any way, such as might have happened from exposure to cold or drip from the roof of the house it grew in, as the palms and other plants standing near it were all quite healthy, and growing luxuriantly. On the pieces of decayed branches which had been cut off, a dark grey fungus was observed in spots of more or less density, having a mealy appearance on the surface, such as some species of fungi belonging to the Sphæria group of that family often have when growing on the decaying branches of plants. It was, therefore, considered to be one of those scavengers of nature, living on and eating away the diseased matter. In a similar manner branch after branch died away through the greater part of last year until February of this year, when the last branch of the formerly magnificent head succumbed. The bare stem then appeared to be more or less covered with the grey fungus which had been observed on the first branches that decayed. Still it was looked on as the consequence, and not the cause of the disease.

At this time, when we were so much perplexed about the loss of this fine plant, the first part of a work, published at Breslau, came to hand, and in it a very elaborate article appears, from the pen of Dr. Schroeter, on the loss of a similar plant to the Glasnevin one, and of the same species, which occurred at the Botanic Garden at Breslau, under precisely similar circumstances, and at the same time. The work is called "Bèiträge zur Biologie der Pflanzen," or Contributions to the Biology of Plants. By Dr. Ferdinand Cohn, of Breslau. In it Dr. Schroeter mentions that the task was assigned to him to investigate, as far as possible, the cause of the death of their fine Pandanus.

On searching through the literature which had been already written on the subject, he found that a disease which attacked the Pandani, had been observed on a plant in the Botanic Garden at Popplesdorf, in 1836. It was also observed some years afterwards in the Botanic

Garden at Berlin, where it was investigated and reported on by M. Bouché, the present inspector of the Berlin gardens. He calls it "Gypfilfaule," and considers it is caused by cold and damp on the plant from the roofs of the conservatories. This disease appears to attack only the young heart-leaves of the plants, and, on their being removed, and kept in drier situations, they generally recovered. This Dr. Schroeter considers a different disease from that which destroyed the plant at Breslau last year, which he calls "Stamfaule," or stem disease; and after reasoning at great length, and with much acumen, on the probable causes which could have led to the destruction of the large plant, comes to the conclusion that it was owing to the ravages of a parasitical fungus, the *Melanconium Pandani, Levielle,* belonging to the Sphæria section of fungi.

It appears this parasite was observed growing on Pandani in the Botanic Garden at Paris a number of years ago, and described by Levielle.

Dr. Schroeter states that on a microscopic examination of the stem of the plant attacked, he found the mycelium of the fungus running longitudinally along the sides of the vascular bundles of tissue and through the cellular tissue. It was not observed to enter the cells, but it formed a network round their walls, and caused a complete disintegration of the substance, which, when dry, had lost all coherence, and could be crumbled into dust. Accompanying this was a second form of fungus, which he calls *Nectria Pandani*. He seems uncertain whether this may not have been produced by the same mycelium, the *Melanconium Pandani*, sprung from, and only a form of that plant, or whether it be a distinct species. The latter I did not observe on our plant, but the former was very abundant, and whether cause or consequence of its death, it played a very important part in hastening decay wherever the disease appeared.

VI.—*On a New Method of Horse Shoeing*. By M. Charlier, V.S.

[Read December 3, 1871.]

The foot of the colt, when in a perfectly natural state, and before it has ever been shod, presents a conformation beautifully adapted for the performance of those functions which by nature it is intended to fulfil; being strong to resist wear and tear, and to support superincumbent weight, as well as yielding, and elastic, to counteract the effects of concussion.

The principle upon which Monsieur Charlier's mode of shoeing is based, is the application of iron, (or any sufficiently hard metal, simple or compound), to that part *only* of the foot of the horse which requires to be protected from the excess of friction which any animal used for

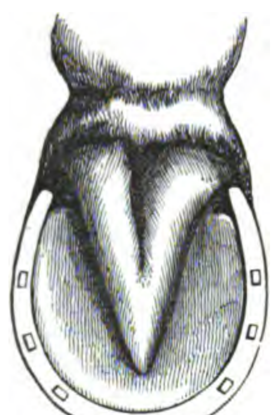
saddle or draught must be exposed to when going rapidly, either upon a paved, or macadamised road, or indeed on hard ground of any kind.

The portion of the hoof subjected to such wear and tear being the lower, or treading portion of the crust, (that which comes into direct contact with the ground), Monsieur Charlier's plan of acting simply is to protect this part from injurious friction, at the same time preserving in its integrity the natural form and structure, and consequently all the functions of the horse's foot. To this end the lower edge of the superficial crust (or wall) only is cut away, the portion removed being replaced by a metallic rim, necessarily more resisting than the natural wall of the foot, but precisely the same in form and thickness as the substance removed.

1.

2.

3.



1. Charlier's drawing knife.
2. Lateral view of the foot showing the groove cut by Charlier's knife for the reception of the shoe.
3. Sole of the foot of a horse shod on Charlier's plan, showing the frog and shoe itself on the same level, with large development of frog.

This metal edging or shoe, lies imbedded in a groove made by Charlier's drawing knife, an instrument constructed for the purpose by the inventor, something resembling an ordinary moulding plane, and which any shoeing smith can use. The shoe thus let as it were into the foot, becomes a continuation of the natural hoof to the tip of

the toe, but not extending beyond it; and in a normal shaped foot at once (or in a weakly foot after about three months duration of this plan of shoeing, and consequent free growth of horn), lies level with the sole and frog, both of which are thus permitted to come into direct contact with the ground.

The frog is never pared, and being left entire soon becomes thick and flexible, and assists to support the body, forming with its spongy upper cushion a medium of elasticity to weaken the shocks upon the tendons and the joints. Its structure too soon resembles india-rubber, and it thus constitutes in the hinder part of the foot a natural elastic wedge which expands, and keeps open wide the heel. The frog also, when well developed, fulfils another office besides strengthening the bearing upon the ground, for it prevents the horse from slipping, acting like the pad under the foot of the camel, dog, or cat. This last function is of very great advantage by securing the safety of the rider, and is all important in the paved streets of towns, when turning sharply round a corner—or in travelling over ice. With Charlier's shoe the sole of the foot is never touched, and the horn being permitted to remain in its normal state grows freely, and is always healthy and strong, for from bearing upon the ground it becomes hard and thick, and able to resist contact with the sharpest stones. Thus is obtained that real cover for the foot so desirable, a good sound sole.

All artificial means to prevent the contact of the sole with the ground have turned out to be, as Professor Williams writes, "injurious," causing wasting, softening, and disease more or less, of the sensitive portions of the foot. The frog and the sole, moreover, appear to be more abundantly secreted the more that they are exposed to attrition; and like the skin of the hand of the blacksmith, or the foot of the beggar boy, who has never worn a shoe, get to be incredibly resisting, and capable of being exposed to very hard and rough usage.

Charlier's method will thus be seen to be directly opposed to the ordinary system of shoeing horses, as generally practised in Great Britain and in France; which system is, in his opinion, neither more nor less than a mutilation of the hoof of the horse by the knife and rasp, with the application to the extremity of the leg of the animal of an unnecessary weight of iron; oftentimes so constructed as to elevate the horse upon a kind of skate, making him to be like unto the ladies with monstrous heels, thus seriously injuring the action of the leg, and (as the ladies) causing to the wearer suffering and torture.

Many of the serious affections of the foot and heels of the horse, especially bad corns, are induced by the present mode of shoeing; a fashion which must be condemned alike by the teachings of science, the reasoning of common sense, and the result of daily observations and experience.

Once again, then, let it be repeated, that the frog and sole must have pressure or they will become useless and diseased. With the foot shod *a la* Charlier, the heels of the horse are kept open, and the bars strong, the frog prominent and flexible, and the soles as firm and thick as the

unshod colt, for they are never touched by a knife. The great enemies to the introduction of this system will be ignorance and routine, but these the friends of progress must destroy by their authority, when the object to be gained is the preservation of such a precious thing as the horse.

As to the material of which this shoe is to be made, it should properly be half steel, half iron. Steel alone (although it may be used) is too brittle, whilst common iron is too soft for durability ; the portion of metal necessary for the shoe being so very slight. Professor Ferguson, of this city, has had a composition bar of steel and iron so constructed that whilst all the toughness of the iron is retained, and fracture thereby obviated, the steel edge enables it to resist the friction of the road for five or six weeks, as long a time as it is desirable to leave the same shoe on. Finally, as to the objects to be gained; corns, contractions, narrow heels, and bruises of the sole are prevented by the Charlier shoe—whilst brushing, speedy cut and over reach are got rid of, the weight of metal appended to the horse's foot being so slight as not to interfere with his natural action; whilst the shape and functions of the foot are left entirely as nature made them.

VII.—*On the Continuity of the Liquid and Gaseous States of Matter*, being the substance of a Lecture, delivered on Saturday, April 29, 1871. By Thomas Andrews, M. D., F.R.S., Vice-President and Professor of Chemistry Queen's College, Belfast.

Material bodies, whether formed of a single element, or by the combination of two or more elements, are known to us only in one or other of three physical states—the solid, liquid, and gaseous. A large number of bodies have been obtained in all these three states, some in not more than two, while a few are known only in one. The element carbon, which in its ordinary crystallized form constitutes the hardest and most brilliant of gems, has never been liquefied; and although it has perhaps been volatilized in the voltaic arc, its properties as a vapour are unknown. Among elementary bodies—hydrogen, oxygen, and nitrogen; among compound bodies—marsh gas, nitric oxide, and carbonic oxide have resisted every attempt to reduce them to the liquid or solid state. Many liquids, too, have refused to solidify even in the intense cold we can now command. There can, however, be little doubt that all bodies, like mercury and water, are capable of existing in the three physical states. We may indeed live yet to see, or at least we may feel some confidence that those who come after us will see, such bodies as oxygen and hydrogen in the liquid, perhaps even in the solid state, and the question of their metallic or non-metallic nature thereby finally settled.

When the same body changes from the solid to the liquid state, and again from the liquid to the gaseous state, its weight remains absolutely unchanged. The same is true generally of all bodies, when, preserving the same physical state, their temperature is altered. Of the truth of these statements there can be no doubt, although it would be difficult to establish them by direct experiments of great precision. It is easy, however, to prove that the escape of large quantities of heat, as in cases of chemical combination, is not accompanied by any loss of weight. In the melting of a solid body, as Black showed long ago, a large quantity of heat is absorbed, and in the conversion of liquids into vapours or gases there is a further and even larger absorption of heat. The full meaning of these important laws will appear hereafter.

It is now nearly fifty years since Faraday showed that many bodies which under the ordinary conditions of the atmosphere are in the gaseous state, may by the application of pressure be reduced to the liquid state; and about the same time Lagnard de la Tour made the important observation that certain liquids, when heated in closed glass tubes, became apparently reduced to vapour in a space from twice to four times the original volume of the liquid.

The continuity of the liquid and gaseous states of matter may at first view appear almost a paradoxical statement. Under the ordinary conditions of temperature and pressure, the passage from the liquid to the gaseous state, or, on the other hand, from the gaseous to the liquid state, is marked by a strong and well-defined break or interruption. Moreover, the physical properties of liquids and gases, under more aspects than one, stand in bold contrast to one another. At common pressures liquids are many hundred times denser than their vapours. They form when in small masses spherical drops, which even in a vacuum evaporate in many cases with extreme slowness, while gases expand apparently without limit as the pressure is removed.

The subject is one of perhaps rather too recondite a character for a general audience; I must therefore crave your kind indulgence, if I fail in my efforts to make it altogether intelligible. Let me, in the first place, explain the meaning of the term pressure of an atmosphere. It is the pressure exerted by the whole superincumbent mass of the air on any given portion of the earth's surface; it varies a little in different places, and in the same place at different times; it is equal to about 15 lbs. on every square inch, and is represented by a column of mercury about 30 inches, or one of water about 34 feet in height. As we descend in the sea, the pressure augments by one atmosphere for every 33 feet. At the depth of 33 feet there will, therefore, be a pressure of two atmospheres—one due to the air, the other to the superincumbent water; and at this depth the air in a diving bell, if not replenished, will be reduced to one-half its volume, according to a great physical law, which commonly bears the name of Mariotte; but was first announced in 1662, at least fourteen years before the publication of Mariotte's work, by the celebrated Boyle, who also established its truth by a number of precise and well-devised experiments.

The following observations, published in 1863, constitute the foundation of this inquiry:—"When carbonic acid is partially liquefied by pressure alone, and the temperature is at the same time gradually raised to 88° F. (31° C.), the surface of demarcation between the liquid and gas becomes fainter, loses its curvature, and at last disappears. The space is then occupied by a homogeneous fluid, which exhibits, when the pressure is suddenly diminished, or the temperature slightly lowered, a peculiar appearance of moving or flickering striæ throughout its entire mass. At temperatures above 88° F. (31° C.) no apparent liquefaction of carbonic gas, or separation into two distinct forms of matter, can be effected, even when a pressure of 300 or 400 atmospheres is applied. Nitrous oxide gives analogous results." This temperature of 88° F. I have since called the critical point of carbonic acid.

The striæ above referred to are characteristic of a homogeneous state of matter in the tube; they are of the same character, but in a greatly exaggerated form, as the movements seen in air, over a heated surface, or in liquids when heated from below. The extraordinary development they assume in this experiment arises from the rapid change of density which carbonic acid undergoes when heated or cooled at temperatures a little above the critical point. Its volume is indeed nearly doubled by an increase of temperature of only 2°. On the other hand, the formation of a cloud shows that the temperature has fallen below the critical point, and that liquefaction has occurred.

Referring to a copy of the diagram representing the effects of pressure upon carbonic acid at different temperatures, which was published in the "Philosophical Transactions" for 1869, the lecturer explained that below 31° carbonic acid, when sufficiently compressed, undergoes a sudden change of volume, and at the same time liquefies; but above 31° no liquefaction takes place, although a rapid fall occurs at one period of the process, when the temperature differs little from 31°. As the temperature is raised this fall becomes less marked, till at 48° it has entirely disappeared, and the curve representing the diminution of volume of carbonic acid approximates throughout its entire course to that for a perfect gas. The concluding part of the lecture may be best given in the following extract from the original memoir already referred to:—

"I have frequently exposed carbonic acid, without making precise measurements, to much higher pressure than 48°, and have made it pass without break or interruption from what is regarded by every one as the gaseous state, to what is, in like manner, universally regarded as the liquid state. Take, for example, a given volume of carbonic gas at 50° C., or at a higher temperature, and expose it to increasing pressure till 150 atmospheres have been reached. In this process its volume will steadily diminish as the pressure augments, and no sudden diminution of volume, without the application of external pressure, will occur at any stage of it. When the full pressure has been applied, let the temperature be allowed to fall till the carbonic acid has reached the ordinary temperature of the atmosphere. During the whole of this ope-

ration no breach of continuity has occurred. It begins with a gas, and by a series of gradual changes, presenting nowhere any abrupt alteration of volume or sudden evolution of heat, it ends with a liquid. The closest observation fails to discover anywhere indications of a change of condition in the carbonic acid, or evidence, at any period of the process, of part of it being in one physical state and part in another. That the gas has actually changed into a liquid would, indeed, never have been suspected, had it not shown itself to be so changed by entering into ebullition on the removal of the pressure. For convenience, this process has been divided into two stages—the compression of the carbonic acid, and its subsequent cooling; but these operations might have been performed simultaneously, if care was taken so to arrange the application of the pressure and the rate of cooling, that the pressure should not be less than 76 atmospheres when the carbonic acid had cooled to 31°.

"We are now prepared for the consideration of the following important question—What is the condition of carbonic acid when it passes, at temperatures above 31°, from the gaseous state down to the volume of the liquid, without giving evidence at any part of the process of liquefaction having occurred? Does it continue in the gaseous state, or does it liquefy, or have we to deal with a new condition of matter? If the experiment was made at 100°, or at a higher temperature, when all indications of a fall had disappeared, the probable answer which would be given to this question is that the gas preserves its gaseous condition during the compression; and few would hesitate to declare this statement to be true, if the pressure, as in Natterer's experiments, were applied to such gases as hydrogen and nitrogen. On the other hand, when the experiment is made with carbonic acid at temperatures a little above 31°, the great fall which occurs at one period of the process would lead to the conjecture that liquefaction had actually taken place, although optical tests carefully applied failed at any time to discover the presence of a liquid in contact with a gas. But against this view it may be urged with great force, that the fact of additional pressure being always required for a further diminution of volume is opposed to the known laws which hold in the change of bodies from the gaseous to the liquid state. Besides, the higher the temperature at which the gas is compressed, the less the fall becomes, and at last it disappears.

"The answer to the foregoing question, according to what appears to me to be the true interpretation of the experiments already described, is to be found in the close and intimate relations which subsist between the gaseous and liquid states of matter. The ordinary gaseous and ordinary liquid states are, in short, only widely separated forms of the same condition of matter, and may be made to pass into one another by a series of gradations so gentle that the passage shall nowhere present any interruption or breach of continuity. From carbonic acid as a perfect gas to carbonic acid as a perfect liquid, the transition we have seen may be accomplished by a continuous process, and the gas and liquid are only distant stages of a long series of continuous physical changes. Under certain conditions of temperature and pressure, carbonic acid

finds itself, it is true, in what may be described as a state of instability, and suddenly passes, with evolution of heat, and without application of additional pressure or change of temperature, to the volume which by the continuous process can only be reached through a long and circuitous route. In the abrupt change which here occurs a marked difference is exhibited, while the process is going on, in the optical and other physical properties of the carbonic acid which has collapsed into the smaller volume, and of the carbonic acid not yet altered. There is no difficulty here, therefore, in distinguishing between the liquid and the gas. But in other cases the distinction cannot be made; and under many of the conditions I have described it would be vain to attempt to assign carbonic acid to the liquid rather than the gaseous state.

"The properties now described as exhibited by carbonic acid are not peculiar to it, but are generally true of all bodies which can be obtained as gases and liquids. Nitrous oxide, hydrochloric acid, ammonia, sulphuric ether, and sulphuret of carbon, all exhibited, at fixed pressures and temperatures, critical points, and rapid changes of volume with flickering movements, when the temperature or pressure was changed in the neighbourhood of those points. The critical points of some of these bodies were above 100°; and in order to make the observations it was necessary to bend the capillary tube before the commencement of the experiment, and to heat it in a bath of paraffin or oil of vitriol.

"We have seen that the gaseous and liquid states are only distant stages of the same condition of matter, and are capable of passing into one another by a process of continuous change. A problem of far greater difficulty yet remains to be solved—the possible continuity of the liquid and solid states of matter. The fine discovery made some years ago by James Thomson, of the influence of pressure on the temperature at which liquefaction occurs, and verified experimentally by Sir W. Thomson, points, as it appears to me, to the direction this inquiry must take; and in the case at least of those bodies which expand in liquefying, and whose melting points are raised by pressure, the transition may possibly be effected. But this must be a subject for future investigation; and for the present I will not venture to go beyond the conclusion I have already drawn from direct experiment, that the gaseous and liquid forms of matter may be transformed into one another by a series of continuous and unbroken changes."

VIII.—*A List of the Species of Sphingidæ in the Collection of the Royal Dublin Society.* By W. F. KIRBY, Assistant in the Museum.

[Read November 21, 1870.]

ALTHOUGH the Entomological Collections of the Royal Dublin Society are not sufficiently extensive to make it worth while to issue catalogues at present, yet it may be useful to lay before the Society, from time to time, lists of the more interesting and best represented groups, which will serve as partial catalogues of the collection.

This evening, therefore, I propose to commence with a list of one of the most interesting groups of moths—the Hawk Moths proper, or *Sphingidæ*. The species marked B. C. are contained in the British collection.

SESIA, *Fabr.*

Bombyliformis, *Linn.*, . . .	B. C., and Switzerland.
Fuciformis, *Linn.*, . . .	Do. do.
Diffinis, *Boisd.*, . . .	Vancouver's Island.
Thysbe, *Fabr.*, . . .	North America.
Saundersii, *Walk.*, . .	India.
Hylas, *Linn.*, . . .	India, Japan.

SATASPES, *Moore.*

Infernalis, *Westw.*, . . .	*India.*

MACROGLOSSUM, *Scop.*

Stellatarum, *Linn.*, . . .	B. C., and Gibraltar.
Titan, *Cram.*, . . .	Central America; Trinidad.
Ceculus, *Cram.*, . . .	South America.
Trochilus, *Hübr.*, . . .	Sierra Leone.
Belis, *Linn.* (?), *Cram.* (*Passalus*, Dru.), ...	Chittagong; India; China.
Gyrans, *Walk.*, . . .	India.
Gilia, *Herr.-Schäff.*, . .	China.

PTEROGON, *Boisd.*

Proserpina, *Pall.*, . . .	Europe.

THYREUS, *Swains.*

Abbotii, *Swains.*, . . .	North America.

AMBULYX, *Walk.*

Substrigilis, *Westw.*, . .	India.

CALYNURIA, *Walk.*

Panopus, *Cram.*, . . .	*East Indies.*

CHÆROCAMPA, *Dup.*

Elpenor, *Linn.*, . . .	B. C.; Ireland.
Celerio, *Linn.*, . . .	India; Gibraltar.
Alecto, *Linn.*, . . .	India.
Nechus, *Cram.*, . . .	Trinidad.
Theylia, *Linn.*, . . .	India.
Oldenlandia, *Fabr.*, . .	India.
Lycetus, *Cram.*, . . .	Australia.
Nessus, *Drur.*, . . .	India, Japan.

The Japanese specimen is much smaller, and also somewhat differently coloured, but is perhaps faded.

Clotho, *Drur.*, . . .	India.
Cyrene (?) *Westw.*, . .	India.
Pallicosta, *Walk.*, . . .	Chittagong.

PERGESA, *Walk.*

Porcellus, *Linn.*, . . .	B. C., Ireland.
Castanea, *Moore, M. L.*, . .	India.
Pluto, *Fabr.*, *Zschach* (*Thorates*, *Hübr.*), ...	Trinidad.

DEILEPHILA *Ochs.*

Livornica, *Esp.*, . . .	Ireland, India.

The Indian specimens, as is sometimes the case with species which occur in both Europe and India, are remarkably small.

Lineata, *Fabr.* (Daucus, *Cram.*),	North America.
Euphorbiæ, *Linn.*, . . .	Hilden, Switzerland.
Nicæa, *De Prun.*, . . .	Europe.
Hippophaes, *Esp.*, . . .	Europe.

PHILAMPELUS, *Herr.*

Satellitia, *Linn.*, . . .	North America.
Labruscæ, *Linn.*, . . .	Guatemala.
Sericeus, *Walk.*, . . .	India.

DARAPSA, *Walk.*

Chærilus, *Cram.*, . . .	North America.
Myron, *Cram.*, . . .	North America.

DAPHNIS, *Hübr.*

Nerii, *Linn.*, ...	India.

PACHYLIA, *Walk.*

Ficus, *Drur.*, ...	Trinidad.
Inornata (?) *Clem.*, . . .	Trinidad.

ZONILIA, *Walk.*	
Hespera, *Fabr.*, . . .	India.
MACROSILA, *Walk.*	
Rustica, *Fabr.*, . . .	Trinidad.
Cluentius, *Cram.*, . . .	*South America.*
Nyctiphanes, *Walk.*, . .	Assam.
Discistriga, *Walk.*, . .	China; India.

The Indian specimens of *M. discistriga* are much smaller than the Chinese, but appear to belong to the same species.

SPHINX, *Linn.*	
Convolvuli, *Linn.*, . . .	B. C.; India.
Ligustri, *Linn.*, . . .	B. C.; Ireland.
Carolina, *Linn.*, . . .	North and South America.
Gordius, *Cram.*, . . .	North America.
ANCERYX, *Walk.*	
Pinastri, *Linn.*, . . .	Hilden.
Ello, *Linn.*, ...	*America.*
Caicus (?) *Cram.*, . . .	Trinidad.
Œnotrus, *Cram.*, . . .	*South America.*
Carica, *Linn.*, . . .	*South America.*
ACHERONTIA, *Hübr.*	
Atropos, *Linn.*, . . .	B. C.; China.
Styx, *Westw.*, . . .	India.
Lachesis, *Fabr.*, . . .	India.
SMERINTHUS, *Latr.*	
Ocellatus, *Linn.*, . . .	B. C., and Ireland.
Tiliæ, *Linn.*, ...	B. C.; Ireland.
Populi, *Linn.*, . . .	B. C.; Hilden; Ireland.
Quercus, *W. V.*, . . .	*Europe.*
Geminatus, *Harr.*, . . .	Nova Scotia.
Excæcatus, *Abrb. & Smith*, .	Nova Scotia.
Modestus, *Harr.*, . . .	Nova Scotia.
Timesius, *Stoll* (*Modesta, Fabr.*),	India.

It has been proposed to separate *Ocellata* and allies from the other species of *Smerinthus;* but the groups are so closely linked by intermediate species, that it is very doubtful whether the genus will admit of subdivision.

IX.—*A List of the Species of Papilioninæ, or Swallow-tailed Butterflies, in the Museum of the Royal Dublin Society.* By W. F. KIRBY, Assistant in the Museum.

[Read Monday, May 22, 1871.]

THE sub-family *Papilioninæ*, which I propose to bring before your notice this evening, though not one of the largest groups of *Lepidoptera*, is in many respects very interesting. It contains most of the species classed as "Equites" by Linnæus.

The first thing that strikes us, on examining the group, is the paucity of well-marked generic forms. The great typical genus *Papilio*, which contains from 350 to 500 species, according as we reckon the numerous doubtful forms as species or varieties, is the only large genus it contains; and no satisfactory attempts have yet been made to subdivide it. Of the eleven other genera, *Parnassius* is the only one of any extent (twenty-five species), the remainder containing only three or four species each, and several only one.

The species contained in the Society's collection belong to the five genera, *Parnassius*, *Eurycus*, *Thais*, *Papilio*, and *Leptocircus*, and of these only it is my present intention to speak. *Parnassius* is a genus of mountain butterflies, not very unlike the white butterflies of our gardens, but much larger. The wings have a gauzy, semitransparent appearance, and they are almost always ornamented with black spots, and generally with red spots or rings also. The best-known species is *Parnassius Apollo*, a very common sub-alpine species in Europe, and a reputed native of Great Britain. Two other species are found in Europe, but a much greater variety is to be met with in the mountains of Central Asia, and several others occur in the Rocky Mountains and California. One of the Himalayan species has a curious dusky variety, of which we possess a specimen.

Next to *Parnassius* comes the curious Australian genus *Eurycus*, remarkable for its almost transparent wings, and for the great dissimilarity in the sexes of the only species. Passing over two small genera, which we do not possess, we come to the genus *Thais*, which contains three species, found on the shores of the Mediterranean, and interesting for the curious festooned markings of their wings.

We now come to the genus *Papilio*, the first section of which has been formed into a separate genus, and called *Troides* or *Ornithoptera*. It contains the largest and some of the most beautiful species, and is confined to the Indian region. I must call your attention particularly to the splendid *P. Crœsus*, recently discovered by Mr. A. R. Wallace in the island of Batchian. Passing over a few species of comparative unimportance—one of which, however, *P. Leonidas*, is remarkable for its resemblance to species of a very different group, the *Danaidæ*—we come to a large group of South American species, black, with white or green

spots on the fore-wings, and with a red band or row of spots, often beautifully opalescent, on the hind-wings. The finest species of this extensive and difficult group is perhaps *P. Sesostris*, with its still more beautiful variety, *P. Childrenæ*. Then comes a group so unlike its allies as to have been placed by Linnæus in a totally different section; after which we arrive at true swallow-tailed butterflies. In some of these, *P. Androgeos* and *P. Torquatus* for example—both South American species—the sexes are remarkably dissimilar. There is a fine group of silky-green Indian species, of which *P. Paris* may be considered the representative. Another very handsome Indian species is *P. Polymnestor*, black and pale blue. We have a curious variety of this, with the blue colour not extending outside the inner row of spots, except along the nervures.

Large as the genus *Papilio* is, it only contains four European species, two of which are in the Society's collection. The first, *Pap. Podalirius*, is common in South and Central Europe, and is reputed British; while the other, *Pap. Machaon*, although common all over Europe and North Asia, extending to the Himalayas and California, is almost confined in Britain to the English fens, and is our only British representative of the sub-family. It appears formerly to have been much commoner in the South of England than it is now.

Finally, the genus *Leptocircus* contains a few small East Indian species or varieties, remarkable for the long appendages to their hind-wings.

I append a list of the species of *Papilioninæ* in the Society's collection, with the localities added, when known:—

PARNASSIUS, *Latr.*

Apollo, *Linn.*, ...	Switzerland and Italy.
Hardwickii, *Gray*, ...	*North India.*
Var. Charnio, *Gray*, ...	*North India.*
Clodius, *Mén.*, ...	Vancouver's Island.
Mnemosyne, *Linn.*, ...	Europe.

EURYCUS, *Boisd.*

Cressida, *Fabr.*, ...	Australia.

THAIS, *Fabr.*

Cerisyi, *Godt.*, ...	Asia Minor.
Rumina, *Linn.*, ...	Gibraltar.

PAPILIO, *Linn.*

Priamus, *Linn.*, var. Crœsus, *Wall*, .	*Batchian.*
Rhadamanthus, *Boisd.*, . . .	*East Indies.*
Pompeus, *Cram.*, ...	*East Indies.*
Leonidas, *Fabr.*, ...	Sierra Leone.
Philenor, *Linn.*, ...	*United States.*
Polydamas, *Linn.*, ...	Trinidad and Central America.

Thymbræus, *Boisd.*, ...	*Central America.*
Phaon, *Boisd.*, ...	*Central America.*
Asius, *Fabr.*, ...	*Brazil.*
Sesostris, *Cram.*, ...	*South America.*
——— var. Childrenæ, *Gray*, .	Nicaragua.
Vertumnus, *Cram.*, var. Erithalion, *Boisd.*,	*South America.*
——— var. Pyrochles, *Doubl.*, .	*New Granada.*
——— var. Alyattes, *Feld.*, .	Nicaragua.
Cymochles, *Doubl.*, Idalion, *Feld.*,	These two forms are probably sexes of one species. Both are from Trinidad.
Eurimedes, *Cram.* ? vars. Tonila and Caleli, *Reak*, ...	*Mexico.*
Æneides, *Esp.*, ...	Trinidad.
Delessertii, *Guer.*, ...	*Singapore.*
Macareus, *Godt.*, ...	*East Indies.*
Clytia, *Linn.*, ...	China.
——— var. Panope, *Linn.*, . .	*East Indies.*
Agestor, *Gray*, ...	*North India.*
Hector, *Linn.*, ...	*India.*
Antiphus, *Fabr.*, ...	*Malayana.*
——— var. Jophon, *Gray*, . .	*Ceylon.*
Aristolochiæ, *Fabr.*, ...	India.
Agavus, *Dru.*, ...	South America and Nicaragua.
Anchisiades, *Esp.*, var. Theramenes, Feld.	Trinidad.
——— var. Idæus, Fabr. .	*South America.*
——— var. Pandion, Feld.,	Nicaragua.
Androgeos, *Cram.*, ...	Trinidad and South America.
Œbalus, *Boisd.*, ...	*Mexico.*
Hectorides, *Esp.*, ...	*Brazil.*
Torquatus, *Cram.*, ...	*South America.*
Thoas, *Linn.*, ...	Sth. America; Trinidad; and Nicaragua.
——— var. Cresphontes, *Cram.*, . .	United States.
Palamedes, *Dru.*, ...	*United States.*
Menestheus, *Dru*, ...	Africa.
Demoleus, *Linn.*, ...	Africa.
Erithonius, *Cram.*, ...	India.
——— var. Sthenelus, *Macl.*, .	Australia.
Demolion, *Cram.*, ...	*East Indies.*
Pammon, *Linn.*, and var. Romulus, *Cram.*,	India.
Canopus? *Westw.*, ...	*Australia.*
Severus, *Cram.*, ...	*Moluccas.*
Helenus, *Linn.*, ...	*East Indies.*
Iswara, *White*, ...	India.
Castor, *Westw.*, ...	India.
Ormenus, *Guér.*, ...	*New Guinea.*

Paris, *Linn*,	India.
Arcturus, *Westw.*,	*North India.*
Ganesa, *Doubl.*,	India.
Polyctor, *Boisd.*,	India.
Bianor, *Cram.*,	China.
Polymnestor, *Cram.*,	India.
Memnon, *Linn.* var. Achates, *Cram.*,	*Malayana.*
Agenor, *Linn.*,	*East Indies.*
Protenor, *Cram.*,	India; China.
Rhetenor, *Westw.*,	India.
Astorion, *Westw.*,	*Esat Indies.*
Latreillii, *Dun.*, var. Philoxenus, *Gray*,	*North India.*
——— var. Ravana, *Moore*,	*North India.*
Dolicaon, *Cram.*, var. Deileon, *Feld.*,	*New Granada.*
Leucaspis, *Godt.*,	*New Granada.*
Calliste, *Bates*,	Guatemala.
Marchandii, *Boisd.*,	New Granada.
Thyastes, *Dru.*,	*Brazil.*
Agesilaus, *Boisd.*,	*New Granada.*
Protesilaus, *Linn.*,	New Granada & Trinidad.
Antiphates, *Cram.*,	India.
Philolaus, *Boisd.*,	*Central America,*
Ajax? *Linn.*	United States.
Podalirius, *Linn.*,	Switzerland and Crimea.
Cloanthus, *Westw.*,	India.
Sarpedon, *Linn*,	India.
Jason, *Linn.*, var. Doson, *Feld.*,	*East Indies.*
——— var. Evemon, *Boisd.*,	*East Indies.*
——— var. Lycaon, *Westw.*,	Australia.
Agamemnon, *Linn.*,	India.
Codrus, *Cram.*,	*East Indies.*
Pylades, *Fabr.*,	Sierra Leone.
Nireus, *Linn.*,	*South Africa.*
Phorcas, *Cram.*,	West Africa.
Merope, *Linn.*,	West Africa.
Cynorta, *Fabr.*,	West Africa.
Zenobia, *Fabr.*,	*West Africa.*
Rutulus? *Boisd.*,	Vancouver's Island.
Glaucus, *Linn.*,	United States.
Xuthus, *Linn.*,	China.
Machaon, *Linn.*,	England; Switzerland; Italy; India.
——— var. Zolicaon, *Boisd.*,	Vancouver's Island.
Polyxenes, *Fabr.*,	United States.
Troilus, *Linn.*,	United States.

Leptocircus, *Swains.*

Meges? *Zink.*,	*East Indies.*

The localities printed in italics are those which belong to species to the specimens of which, in the Society's collection, no localities are attached.

X.—*Notes on Three Species of Trap-door Spiders, whose Nests are in the Royal Dublin Society's Collection.* By W. F. KIRBY, Assistant in the Museum.

[Read May 22, 1871.]

As there are in the collection of the Royal Dublin Society three Trap-door Spiders' nests, and the architects of two of them, I propose to put together the remarks of some of the numerous observers who have written on these interesting creatures.

The Spiders which make their nests in the ground, and close them with a trap-door, all belong to the *Mygalidæ*—a family which includes the great venomous bird-catching Spiders of South America. The only British representative of the family is a Spider called *Atypus Sulzeri* (Latr.), which forms a tunnel in damp earth, lined with a tube of close-textured white silk, in which the animal itself lives, and in which the cocoon, or rather egg-bag, is deposited.* The tube, however, is not closed with a trap-door.

Although no British Spider makes a trap-door in its nest, several exotic species do so; and the first to which I have to call your attention is *Cteniza ionica* (Saund.), which is found in Corfu. This species and its tube have been well described and figured by Mr. S. S. Saunders.† He remarks:—"These nests were found close round the roots of the olive trees, in a somewhat elevated situation, and were generally observed, two or three together, about the same tree. The soil was a sort of sandy clay, of a light ochreous colour. The upper portion of the nests was also partially raised above the surface of the ground. A projection above the hinge, varying in size, occurs in the nest. When the spider is in its tube, it clings with great force to the lower part of the lid, to prevent its being opened." In some cases Mr. Saunders found the nests provided with a door at each extremity. His first idea was that this was for the purpose of drainage, but he afterwards came to the conclusion that it was due to the nest having been accidentally inverted, perhaps in digging round the olive trees. He sometimes found that the spiders completely blocked up the door of the nest with a thick web. In the course of long observation, he never observed any of the spiders to leave their nests of their own accord, or even to have the door open either by night or day. It is probable, however, that their habits may be similar to those of *C. Ariana* (Walck.), which were observed by Erber in the island of Tinos.‡

This species leaves its burrow about 9 o'clock in the evening, fastens open the door by a thread attached to the nearest stone or stalk, spins a small web, six inches long by half an inch high, and then

* Staveley's "British Spiders," p. 35.

† "Trans. Ent. Soc. Lond.," iii., pp. 160-170, Pl. 9.

‡ "Verhandl. Zool., Bot. Gesellsch. in Wien," 1868, p. 905.

retreats to its nest. Night-roving beetles soon get entangled in the webs, and the spiders, after sucking out their juices, remove them to a distance of several paces from their nests. On returning to their nests they remove the web entirely, and Erber thinks they incorporate it with the trap-door. In the day time the trap-doors are always closed. The eggs are laid at the bottom of the burrows, each separately, kept in place by a thread. The young spiders begin to form their nests very early, as Erber found some nests only three inches deep, with a perfectly-formed trap-door, while their occupants did not exceed two lines in length.

Our second nest is accompanied by the architect, and is that of *Actinopus nidulans* (Fabr.), a Jamaican species, which has been known since 1756, when Dr. Patrick Browne published a notice of its habits in his "Natural History of Jamaica," which I quote from the second edition (1789), p. 420:—"Tarantula 2, *Fusca major sublierenta subteram nidulans*—the black Tarantula. This sort is represented of the natural size, as well as its nest and both its valves, which are so well contrived, and so strongly connected, that whenever they are forced open, the native elasticity of the ligaments that fix them restore them immediately to their usual position. It is most frequent in the loose rocky soils, and nestles under ground. Its nip is very painful for many hours, and sometimes raises a fever and deliriums; but these are commonly eased by throwing the patient into a moderate sweat, which is commonly done with a little warm rum punch among the negroes, who are most subject to these accidents. This puts them soon asleep, and in a few hours they are quite recovered." Spirits seem to be an antidote to most animal poisons, and are frequently used in cases of snake bites.

The spider and its nest are figured in the "Natural History of Jamaica," Pl. 44, fig. 3, *3a*, *3b*. Dr. Browne represents it with two valves; upon which Professor Westwood remarks,* that either Dr. Browne's observations are inaccurate, or that there is more than one species of Trap-door Spider in Jamaica, or that the spider occasionally forms two valves to its nest from some accidental cause. A very full description of the nest has been published by Mr. Sells,† and he mentions that one of his specimens contained a double valve. He suggests that this may be owing to the hinge of the original door having lost its elasticity from long use, the weather, or other cause. Mr. Gosse‡ has also published an account of this spider. He believes the spider first digs a small hole, and then begins to form the trap-door and lining of the nest, deepening the nest gradually, and spinning the lining first in patches where the mould is most liable to fall in. "These are overlaid with other patches, more and more extensive, until the whole interior

* "Trans. Ent. Soc. Lond.," iii., p. 172.

† "Trans. Ent. Soc. Lond.," iii., p. 175.

‡ "Travels into the Interior of Southern Africa in the years 1797 and 1798." London, 1801. i., p. 392.

walls are covered; after which the silk is spun evenly and continuously all round the interior, in successive layers of very dense texture, though thin." A row of minute holes are at least occasionally pierced round the free edge of the lid, and a double row of similar ones just within the margin of the tube. It has been suggested that these were for the spider to work its claws into, to hold the door tightly closed; but Gosse is more inclined to think that they are air holes.

The spider, like others of similar habits, is very sluggish when dragged out of its nest; its bite is still reputed to cause tumefaction and painful fever.

Our third nest, also accompanied by the architect, is from Natal. The nest and spider much resemble *Actinopus ædificatorius* (Westw.),* from North Africa, which, however, is a much smaller species. The Natal spider has the cephalo-thorax of a dark reddish-brown or chestnut colour, the hinder part lighter, and the abdomen of a yellowish-brown; there is a pale band, almost white, on the vertex, and the articulations of the joints are very distinctly white, which gives the spider the appearance of having the legs annulated.

Another Trap-door Spider from South Africa, *Mygale Barrowi* (Walck.), has been noticed by Barrow,† but his description, imperfect as it is, does not seem to agree with our specimen. Barrow's account is as follows:—"It was said that the root of this bulb (*Amaryllis disticha*), mixed up with the mangled body of a species of spider, furnishes the Bosjesmans with poison for their arrows more deadly than any other they are acquainted with. This spider should seem to be peculiar to the western coast of the country, at least I never met with nor heard of it on the other side. Its body, with the legs, which are short, is three inches in diameter—the former black and hairy, the latter faintly spotted, the beak red. It lives under ground, constructing over its hole a cover composed of the filaments spun from its entrails, and earth, or dung. This cover is made to turn on a joint. When the animal is watching for its prey, it sits with the lid half open, ready to sally out upon such insects as serve it for food. On the approach of danger it closes the cover, and in a short time cautiously opens it again to see if the enemy has retreated."

It may be mentioned here that Walckenaer‡ says that ants are the great enemies of the mason spiders.

Livingstone§ gives the following account of another spider:— "A large reddish spider (*Mygale*) obtains its food in a different manner than either, patiently waiting in ambush, or by catching it with a bound. It runs about with great velocity, in and out, behind and around every object, searching for what it may devour, and from its

---

* "Trans. Ent. Soc. Lond.," ii., pp. 207-210, Pl. 19.

† "Naturalist's Sojourn in Jamaica," pp. 115-118.

‡ Walckenaer, "Hist. Nat. des Insectes." Apteres, i., p. 239.

§ "Missionary Travels and Researches in South Africa," pp. 325, 326.

size and rapid motions excites the horror of every stranger. I never knew it to do any harm, except frightening the nervous, and I believe few could look upon it for the first time without feeling himself in danger. It is named by the natives 'selâli,' and is believed to be the maker of a hinged cover for its nest. You see a door, about the size of a shilling, lying beside a deep hole of nearly similar diameter. The inside of the door, lying upwards, and which attracts your notice, is of a pure white silky substance, like paper. The outer side is coated over with earth, precisely like that in which the hole is made. If you try to lift it, you find it is fastened by a hinge on one side; and if it is turned over on the hole, it fits it exactly; and the earthy side being then uppermost, it is quite impossible to detect the situation of the nest. Unfortunately, this cavity for breeding is never seen, except when the owner is out, and has left the door open behind her."

Dr. Livingstone seems to be in error about the spider which forms this nest, as the *Mygalidæ* are mostly very sluggish animals. The specimens of Trap-door Spiders and their Nests in the Museum of the Royal Dublin Society are as follows:—

1. Nest from Corfu, belonging to *Cteniza Ionica*, presented by his Grace the Archbishop of Dublin.

2. Nest and Spider from Jamaica, *Actinopus nidulans*, presented by Sir F. L. M'Clintock, R. N.

3. Nest and Spider from Natal, presented by W. L. Anderson, Esq.

XI.—*Account of Experiments upon the Mechanical Efficiency of different Forms of Pulley Blocks.* By ROBERT STAWELL BALL, A. M., Professor of Applied Mathematics and Mechanism, Royal College of Science for Ireland.

[Read May 13, 1870; and May 22, 1871.]

IF a load R be raised by a pulley block on the application of the power P, the following relation subsists between the magnitudes P and R.

$$P = a + bR.$$

a, b are constant quantities for each different form of pulley block.

These constants are determined in the following manner:—A series of loads R_1, R_2, R_3, &c., are attached to the hook which receives the loads. It is found by trial that certain powers, P_1, P_2, P_3, &c., are required to raise the corresponding loads. We have, therefore, the following series of equations:—

$$\begin{aligned} P_1 &= a + bR_1, \\ P_2 &= a + bR_2, \\ P_3 &= a + bR_3. \\ \&c. &= \&c. \end{aligned}$$

From these equations the quantities a, b are to be determined either by the method of least squares, or by the method of graphic construction. (See Ball's "Experimental Mechanics," Appendix.)

In examining the theory of any mechanical power, it is of the utmost importance to determine the velocity ratio. The best mode of finding this is by actual trial. Let a load, suppose of 56 lbs., be suspended from the load hook, then if n be the number of feet through which the power must be exerted in order to raise the load one foot, n is the velocity ratio.

It is known from the principle of energy that if there were no friction in the pulley, the power would be merely the n^{th} part of the load. In the following Tables the mechanical efficiency is found by dividing the mean value of R by the corresponding value of P. There is, for example, in Table III. of the differential pulley the formula

$$P = 3{\cdot}87 + 0{\cdot}1508\,R;$$

the highest load is 560 lbs., half this is 280 lbs.; the power corresponding to 280 lbs. is

$$3{\cdot}87 + 0{\cdot}1508 \times 280 = 46{\cdot}09 \text{ lbs.}$$

The mechanical efficiency is

$$\frac{280}{46{\cdot}09} = 6{\cdot}07.$$

Thus the mechauical efficiency of the differential pulley is a little over sixfold.

In order to deduce the percentage of useful effect, we must compare this with the velocity ratio. To raise 280 lbs. one foot, a power of 46·09 lbs. has to be exerted through a space of 16 feet.

Hence the number of units of work is

$$46{\cdot}09 \times 16 = 737{\cdot}4;$$

but of this amount only 280 units are usefully expended, and therefore the percentage of energy utilized is

$$\frac{28000}{737{\cdot}4} = 38.$$

The differential pulley is one of a large class of mechanical powers which possess the remarkable property of sustaining their loads without the necessity of holding or securing the lifting chain. This arises from the excessive friction in these machines.

The following investigation will show the general principles upon which it can be ascertained whether a given mechanical power will "overhaul" or not:—

P is the power necessary to raise the load R, n is the velocity ratio.

To raise R one foot nP units of work are required, and since only R of these units are usefully expended,

$$nP - R \text{ units}$$

must be expended upon friction.

Now let the power P be removed; since the upper pulley block supports a smaller weight, the friction is diminished at that block, though remaining the same at the lower block. The entire friction is not, therefore, diminished in a greater ratio than that of R to $P+R$. Hence the number of units of energy necessary to overcome friction in the descent of the weight is not less than

$$(nP - R)\frac{R}{P+R};$$

but by the descent of the load only R units of work can be accomplished, and therefore the block will not overhaul, if

$$(nP - R)\frac{R}{P+R} > R,$$

$$\text{or if} \qquad nP - R > P + R,$$

$$\text{or} \qquad P > \frac{R}{n-1}.$$

In the case of the differential pulley,

$$R = 280, \ n = 16;$$

$$\frac{2R}{n-1} = 37{\cdot}3,$$

and since P is 46·09 lbs. the weight cannot overrun.

On the other hand, if

$$R > nP - R,$$

$$\text{or } P < \frac{2R}{n},$$

the block will certainly overhaul.

Thus, for example, in the three-sheave pulley block Table II.,

$$R = 228 \text{ lbs.}, \ n = 6;$$

$$\frac{2R}{n} = 76, \text{ while } P \text{ is } 56,$$

therefore this block does overrun.

We may say approximately that if less than 50 per cent. of the power be consumed by friction, the block will overrun; while, if more than 50 per cent. of the power be consumed by friction, the block will not overrun.

The result at which we have arrived may be also stated in a slightly different manner. Let e be the mechanical efficiency when a load R is raised; if then $e < \frac{n-1}{2}$, the machine will certainly not overhaul; if $e > \frac{n}{2}$, the machine will certainly overhaul; while if e be intermediate between $\frac{n}{2}$ and $\frac{n-1}{2}$, the actual details of the particular pulley block under examination must be considered.

The tables are constructed on an uniform plan. In the first column is found the numbers of the experiments; the second contains the loads raised; the third gives the corresponding observed value of the power; the fourth gives the value of the power calculated from the formula; the fifth gives the difference between the calculated and observed values as a means of judging of the correctness of the formula employed.

TABLE I.—SINGLE MOVEABLE PULLEY.

Moveable pulley of cast iron 3″·25 diameter, groove 0″·6, wide, wrought iron axle, 0″·6 diameter; fixed pulley of cast iron 5″ diameter, groove 0″·4, wide; wrought iron axle 0″·6 diameter, axles oiled; rope 0″·25 diameter; velocity ratio 2; mechanical efficiency 1·8; useful effect 90 per cent.; formula $P = 2{\cdot}21 + 0{\cdot}5453\,R$.

Number of Experiment.	*R.* Load in lbs.	Observed power in lbs.	*P.* Calculated power in lbs.	Difference of the observed and calculated values.
1	28	17·5	17·5	0·0
2	57	33·5	33·3	− 0·2
3	85	48·5	48·6	+ 0·1
4	113	64·0	63·8	− 0·2
5	142	80·0	79 6	− 0·4
6	170	94·5	94·9	+ 0·4
7	198	110·5	110·2	− 0·3
8	226	125·5	125·5	0·0

Table II.—Three-Sheave Pulley Blocks.

Sheaves cast iron, 2″·5 diameter; rope 0″·25 diameter; velocity ratio 6; mechanical advantage 4; useful effect 67 per cent.; formula $P = 2·36 + 0·238\ R$.

Number of Experiment.	*R.* Load in lbs.	Observed power in lbs.	*P.* Calculated power in lbs.	Difference of the observed and calculated values.
1	57	15·5	15·9	+ 0·4
2	114	29·5	29 5	0·0
3	171	43·5	43·1	− 0·4
4	228	56·0	56·6	+ 0·6
5	281	70·0	69·2	− 0·8
6	338	83·0	82·8	− 0·2
7	395	97 0	96·4	− 0 6
8	452	109·0	109·9	+ 0·9

Table III.—Weston's Differential Pulley Block.

Circumference of large groove 11″·84, of small groove 10″·36; velocity ratio 16; mechanical efficiency 6·07; useful effect 38 per cent.; formula $P = 3·87 + 0·1508\ R$.

Number of Experiment.	*R.* Load in lbs.	Observed power in lbs.	*P.* Calculated power in lbs.	Difference of the observed and calculated values.
1	56	10	12·3	+ 2·3
2	112	20	20·8	+ 0·8
3	168	31	29·2	− 1·8
4	224	38	37·7	− 0·3
5	280	48	46·1	− 1·9
6	336	54	54·6	+ 0·6
7	392	64	63 1	− 0·9
8	448	72	71·5	− 0·5
9	504	80	80·0	0·0
10	560	86	88·4	+ 2·4

Table IV.—Eade's Epicycloidal Pulley Block.

Size adapted for lifting weights up to 5 cwt.; velocity ratio 12·5; mechanical efficiency 5; useful effect 40 per cent.; formula $P = 5·8 + 0·185\ R$.

Number of Experiment.	*R.* Load in lbs.	Observed power in lbs.	*P.* Calculated power in lbs.	Difference of the observed and calculated values.
1	56	15	16·2	+ 1·2
2	112	27	26·5	− 0·5
3	168	40	36·9	− 3·1
4	224	47	47·2	+ 0·2
5	280	56	57·6	+ 1·6
6	336	66	68·0	+ 2·0
7	392	78	78·3	+ 0·3
8	448	88	88·6	+ 0·6
9	504	100	99·0	− 1·0
10	560	110	109·4	− 0·6

TABLE V.—MOORE'S PATENT PULLEY BLOCK.

Size adapted for lifting 10 cwt. ; velocity ratio 31·6 ; mechanical efficiency 10·4; percentage of useful effect 30; formula $P = 3·0 + 0·0805\ R$.

Number of Experiment.	*R.* Load in lbs.	Observed power in lbs.	*P.* Calculated power in lbs.	Difference of the observed and calculated values.
1	63	8	8·1	+ 0·1
2	119	13	12·6	− 0·4
3	175	17	17·1	+ 0·1
4	231	22	21·6	− 0·4
5	287	26	26·1	+ 0·1
6	343	30	30·6	+ 0·6
7	399	35	35·1	+ 0·1
8	455	40	39·7	− 0·3
9	511	44	44·3	+ 0·3
10	567	49	48·6	− 0·4

TABLE VI.—MOORE AND HEAD'S PATENT HAND-HOIST.

Velocity ratio 5·16 ; mechanical efficiency 4·2; percentage of useful effect 81 ; formula $P = 0·6 + 0·232\ R$.

Number of Experiment.	*R.* Load in lbs.	Observed power in lbs.	*P.* Calculated power in lbs.
1	62	15	15
2	118	28	28
3	174	41	41
4	230	54	54

XII.—*On the Nature and Constitution of some new Compounds of Mercury with certain Ketones.* By J. EMERSON REYNOLDS, Member of the Royal College of Physicians, Edinburgh, Keeper of the Mineral Department, and Analyst to the Royal Dublin Society.

[Read March 20, 1871.]

ABOUT ten years ago I laid before the Society an account of some experiments on "*Wood Spirit and its detection*,"* in the course of which a peculiar reaction of acetone (one of the constituents of commercial wood spirit) was described. It was shown in the Paper referred to that mercuric oxide, when freshly precipitated, dissolves completely in potassium hydrate in presence of acetone, and yields a liquid possessing highly characteristic properties.

In a Paper† recently communicated to the Royal Society of London the general investigation of the above reaction has been detailed, and I have there shown, (1) that not only acetone but other members of the group of fatty ketones can be made to unite directly with mercuric oxide; (2) that the resulting compounds afford a new group of colloid hydrates, analogous in properties to the silicic, albuminic, and other hydrates made known by the researches of Professor Graham; (3) that the new hydrates may best be regarded as *extremely feeble conjugate acids*, the chief member of the group (that derivable from acetone) being tetrabasic, and capable of affording very unstable salts; and (4) that the liquid acid or hydrate is capable of affording a gelatinous hydrate, and the latter can in turn be wholly deprived of water and an anhydrous body obtained incapable of again uniting with the elements of water to re-form the original liquid or gelatinous hydrate. The formula of the anhydrous body obtained from the aceto-mercuric compound has been proved to be

$$((CH_3)_2CO)_2Hg_3O_3.$$

In the present communication I venture to add some remarks on the probable chemical constitution of the above-mentioned bodies derivable from acetone. In order to make these observations intelligible, however, it will be necessary to state here in general terms the mode of preparing the aceto-mercuric hydrate, the evidence of its acid character, and of the basicity of the acid.

The liquid colloid body is prepared by adding to a dilute solution of potassium hydrate with a quantity of acetone, a solution of mercuric chloride; oxide of mercury is precipitated at first, but speedily unites

* "Journal of the Royal Dublin Society," vol. iv., p. 114.
† "Proceedings of the Royal Society, 1871," p. 431.

with the acetone when the mixture is warmed, and the resulting compound dissolves in the alkali. When the clear alkaline liquid so obtained is placed in a hoop dialyzer, and the latter floated in a considerable bulk of distilled water, the potassium chloride formed in the above reaction and potassium hydrate diffuses away, and can be thus completely removed from the mercuric compound which remains behind in the dialyzer as a liquid colloid hydrate. The latter body is extremely susceptible of change to the condition of gelatinous hydrate by heat, or contact with traces of acids, strong alkalies, or many neutral salts, and on dessication yields the anhydrous body above referred to. The original alkaline liquid on treatment with an acid in slight excess affords at first a somewhat gelatinous white precipitate, which speedily becomes the yellowish-white and dense anhydrous body. The latter is insoluble, without decomposition, in acid liquids hitherto tried.

The solution of potassium hydrate used in the first instance may be replaced by solution of sodium, barium, or even calcium hydrate, and yet the same ultimate result arrived at. When sodium hydrate is employed, no material difference is observed at any stage of the operations, but when barium hydrate is substituted, re-solution of mercuric oxide in presence of acetone is quickly effected with the aid of heat; but this alkaline solution slowly decomposes, yielding a white precipitate of the mercuric ketone compound, mixed with a little barium carbonate. This decomposition takes place in closed vessels, and most rapidly when the solution has been boiled in course of preparation, and when no excess of barium hydrate has been employed beyond the amount absolutely required to secure the retention of the mercuric compound in solution.

Keeping in view the peculiar mode of generation of the mercuric ketone compound, its solubility in alkaline liquids at the time of its formation, and insolubility without decomposition in acid solutions, its power of uniting with water to form both liquid and gelatinous hydrates, and the extremely close analogy of these in properties and relations to the "cosilicic acids" of Prof. Graham, we are compelled to attribute to the new hydrates very feeble acid functions.

The alkaline solutions above referred to may therefore, as above stated, be regarded as containing metallic salts of a peculiar acid, derived from the compound $((CH_3)_2CO)_2Hg_3O_3$. That these salts are, however, even more easily decomposed than alkaline silicates is shown :—

1st. By the easy decomposition of the potassium salt by the process of liquid diffusion. The osmotic force alone is sufficient for this purpose, the high diffusive energy of potassium hydrate enabling it to rapidly pass through the dialytic septum, leaving behind the colloid acid in the liquid state. The analogous decomposition occurs somewhat less readily in the case of sodium silicate.*

* Graham, "Phil. Mag.," vol. xxviii., p. 319.

2nd. By the facility with which the new acid may be displaced from the aqueous solutions of its potassium, sodium, or barium salts by so feeble an agent as carbonic acid. Solutions of alkaline silicates are well known to decompose in the same manner, but less rapidly.

3rd. By the fact that heat alone is able to effect the decomposition of the potassium salt, a solution of the latter giving a yellowish-white precipitate of the anhydrous mercuric ketone compound *on violent ebullition*, the alkali remaining dissolved.* Re-solution does not take place on cooling, or on digestion with an excess of the metallic hydrate at the ordinary temperature.

It is, however, worthy of note here that the gelatinous precipitate produced by acetic acid in a solution of the potassium salt is soluble in excess of potassium hydrate *immediately after its formation*; but it soon loses this property, and alters somewhat in appearance, becoming more dense.

With a view to obtain, if possible, some evidence of the basicity of the acid, a quantity of mercuric chloride was dissolved in water, the theoretical proportion of pure acetone added, and excess of potassium hydrate. Complete re-solution of the mercuric oxide was obtained as usual. To the alkaline liquid dilute hydrochloric acid was added, until a moderate quantity of the white mercuric acetone compound had been precipitated. The whole was then filtered as clear as possible. The filtrate now contained, in addition to potassium chloride resulting from the reaction, a certain amount of the mercuric acetone compound, held in solution by a *minimum* of alkali. In order to determine the ratio between the anhydride or acid and potassium present in combination, 100 cub. centims. of this solution were now taken, treated with excess of hydrochloric acid, and the mercury precipitated as sulphide by means of sulphuretted hydrogen. The pure mercuric sulphide obtained in this manner weighed 1·056 gramme: this amount represents 1·1591 gramme of the anhydrous mercuric acetone compound, as calculated from the formula already found for that body.

Another 100 cub. centims. of the same solution were taken, and dilute sulphuric acid of known strength very cautiously added, until a drop of the liquid faintly reddened blue litmus-paper: 5·4 cub. centims. of acid were required; this amount of acid represented ·2106 gramme of potassium.

100 cub. centims. of the solution, completely free from *excess* of alkali, therefore contained of

	grm.
$(CO(CH_3)_2)_2Hg_3O_3$	1·1591
K'	·2106

* In this, as in many other respects, a *strong* solution closely resembles in deportment a liquid containing *white of egg*.

These numbers, when divided in the usual way by the respective atomic weights, gave the proportion of 1 : 3·6.

The foregoing experiment is but one of many performed with a similar result, the mean ratio found for different solutions being 1 : 3·7. When the conditions under which the determinations were made are considered, the ratio 1 : 4 may be admitted as the true result.

A solution of the barium salt was now prepared with great care, the presence of excess of barium hydrate being guarded against by very cautious manipulation in the first instance, and subsequent treatment with acetone and mercuric chloride, until the liquid ceased to dissolve more mercuric oxide. The acid treatment resorted to in the case of the potassium salt was found to be unsuitable in the present instance: 100 cub. centims. of the clear filtered liquid were taken, immediately after preparation of the solution, and treated with excess of hydrochloric acid until complete decomposition was effected; the mercury was then precipitated as sulphide: ·5062 gramme was obtained; this amount represents ·5555 gramme of the anhydrous mercuric acetone compound.

100 cub. centims. were treated with a standard acid : 3·3 cub. centims. were required before an acid reaction was developed; this corresponds to ·2244 gramme of barium.

We therefore find in 100 cub. centims. of the solution of

		grm.
$(CO(CH_3)_2)_2Hg_3O_3$	. . . .	·5555
Ba''	. . .	·2244

When these numbers are treated as before, we find that the ratio of anhydrous ketone compound to barium is 1 : 1·84. As in the case of the potassium salt, the chances of error are altogether in the direction of under-estimating the barium and over-estimating the remaining constituent of the salt; the ratio 1 : 2 may therefore fairly be taken as the practical result of these determinations.

Potassium being monovalent and barium divalent, it would appear that the solutions above mentioned contained respectively the normal potassium and barium salts of an *extremely feeble* but yet distinctly marked tetrabasic acid. When any one of these liquids was evaporated to dryness *in vacuo* over sulphuric acid, a resinoid mass was in each case obtained, from which metallic chloride was removable by water; but since partial decomposition appeared to take place during the process of evaporation in each case, the now insoluble resinoid body, containing potassium, sodium, or barium, could not be regarded as a pure salt.

The above facts and the inferences just drawn from them, warrant us now in endeavouring to explain the constitution of the acid—that derived from acetone more particularly—and the formula of which we may provisionally write.

$$(CH_3)_2CO)_2Hg_3\ O_3,\ (OH)_4.$$

or on the water type—

$$\left.\begin{array}{r}(CH_3)_2CO)_2Hg_3O_3\\ H_4\end{array}\right\}O_4$$

The new acid we may call *di-aceto-mercuric-acid*, and the group of bodies of which this is probably the first member *di-keto-mercurates.*

The constitution of the acid may, however, be best represented by the following construction.*

$$\left\{\begin{array}{c}(CH_3)_2COHgO\left\{\begin{array}{l}H_2\\ O\end{array}\right.\\ HgO\\ (CH_3)_2COHgO\left\{\begin{array}{l}O\\ H_2\end{array}\right.\end{array}\right.$$

And that of the anhydrous compound—

$$\left\{\begin{array}{c}(CH_3)_2COHgO\\ HgO\\ (CH_3)_2COHgO\end{array}\right.$$

While the potassium and barium salts become respectively—

$$\left\{\begin{array}{c}(CH_3)_2COHgO\left\{\begin{array}{l}K_2\\ O\end{array}\right.\\ HgO\\ (CH_3)_2COHgO\left\{\begin{array}{l}O\\ K_2\end{array}\right.\end{array}\right.$$

And

$$\left\{\begin{array}{c}(CH_3)_2COHgO\left\{\begin{array}{l}Ba\\ O\end{array}\right.\\ HgO\\ (CH_3)_2COHgO\left\{\begin{array}{l}O\\ Ba\end{array}\right.\end{array}\right.$$

It will be observed that in the construction of these formulæ the tetravalence of mercury is almost of necessity assumed, as in this way we are enabled to give a simple explanation of certain phenomena otherwise extremely difficult of elucidation. It is certain that in most mercuric compounds the metal is divalent, but there is some evidence to prove that in certain states of combination the atom of mercury exhibits a still higher combining power than is usually attributed to it;† but this additional attractive force is evidently of very low intensity, and only comes into play under exceptional conditions; hence compounds resulting from the operation of this feeble attractive power, may be expected to prove very unstable, if the conditions under

---

* Since treatment of the acid with sulphuretted hydrogen resolves the compound into mercuric sulphide, ordinary acetone (as proved by the vapour density of the product) and water, it is not improbable that the two molecules of acetone are bound together by means of mercuric oxide.

† The evidence referred to in the text is chiefly that derived from the composition of the large groups of so-called double salts which dyad mercury is known to afford.

which they may be placed should, in even a very slight degree, favour the reversion of the mercury in the compound to its usual pseudo-divalent character. The liquid acid above described may fairly be regarded as such an unstable body, wherein the elements of two atoms of water are held in very feeble combination, owing to the attractive powers of two tetravalent atoms of mercury; but dessication of this acid at ordinary temperatures is sufficient to resolve it into water and a solid anhydrous body no longer capable of conversion into a liquid acid.

This is true, in a limited sense, of the metallic salts likewise, for simple heating of a normal solution of one of the soluble salts of the acid—the potassium salt for instance—quickly effects the decomposition into metallic hydrate and anhydrous mercuric compound obtained in the former case. Finally, the addition of an acid to the solution of the potassium salt causes a precipitate, soluble in excess of potassium hydrate, immediately after production; but in a very short time the precipitate ceases to dissolve in the alkali, having, probably, passed into the usual anhydrous condition.

The change from the acid body, in which the mercury is regarded as being tetravalent, to the anhydrous compound, in which it may be considered pseudo-divalent, can be thus represented by the formula—

For the acid—

$$\left\{\begin{array}{lr} (\mathrm{CH_3})_2 = \mathrm{C^{iv}} - \mathrm{O''} - \mathrm{Hg^{iv}} - \mathrm{O,'''} & \begin{array}{c}\mathrm{H''}\\ \mathrm{O''}\end{array} \\ \qquad\quad | & | \\ \qquad\quad \mathrm{Hg^{iv}} = \mathrm{O''} & \\ \qquad\quad | & | \\ (\mathrm{CH_3})_2 = \mathrm{C^{iv}} - \mathrm{O''} - \mathrm{Hg^{iv}} - \mathrm{O,'''} & \begin{array}{c}\mathrm{O''}\\ \mathrm{H'_2}\end{array} \end{array}\right.$$

For the anhydrous body—

$$\left\{\begin{array}{l} (\mathrm{CH_3})_2\mathrm{C^{iv}O''Hg''O''} \\ \qquad\quad | \qquad\quad | \\ \qquad\quad \mathrm{Hg''O''} \\ \qquad\quad | \qquad\quad | \\ (\mathrm{CH_3})_2\mathrm{C^{iv}OHg''O''} \end{array}\right.$$

Applying the principle of apparent change of quantivalence of the mercury to the other compounds, it will be seen from the construction of the formula of the barium di-aceto-mercurate, that two isomeric salts of a divalent metal can exist—one in which the mercury is tetravalent, and the second in which it is pseudo-divalent. The difference may be represented in the following way. The normal barium di-aceto-mercurate being:—

(*a*)

$$\left\{\begin{array}{lr} (\mathrm{CH_3})_2\mathrm{COHg^{iv}O,'''} & \begin{array}{c}\mathrm{Ba''}\\ \mathrm{O}\end{array} \\ \qquad | & | \\ \qquad \mathrm{Hg^{iv}O''} & \\ \qquad | & | \\ (\mathrm{CH_3})_2\mathrm{COHg^{iv}O,'''} & \begin{array}{c}\mathrm{O}\\ \mathrm{Ba''}\end{array} \end{array}\right.$$

The isomeric body containing pseudo-divalent mercury would be—

$$(\beta)\qquad \left\{\begin{array}{lc} (CH_3)_2COHg''O & Ba''O \\ \quad\;\, | & | \\ \quad HgO & \\ \quad\;\, | & | \\ (CH_3)_2COHg''O & Ba''O \end{array}\right.$$

Further, the last body might lose an atom of barium and of oxygen in presence of water, and become—

$$(\gamma)\qquad \left\{\begin{array}{l} (CH_3)_2COHgO'' \\ \quad\;\, | \\ \quad HgO \\ \quad\;\, | \\ (CH_3)_2COHgO'' \end{array}\right\rangle BaO''$$

in which the divalent group BaO'', would serve to unite the oxygen at the end of each chain.

Of di-aceto-mercurates, containing a monovalent metal—potassium for instance—we could expect to find but two classes; (*a*) the normal salt of the tetrabasic acid already described, containing tetravalent mercury—

$$\left\{\begin{array}{lc} (CH_3)_2COHg^{iv}O,''' & \begin{array}{c}K_2\\O\end{array} \\ \quad\;\, | & | \\ \quad HgO & \\ \quad\;\, | & | \\ (CH_3)_2COHg^{iv}O,''' & \begin{array}{c}O\\K_2\end{array} \end{array}\right.$$

probably incapable of isomeric modification: and (*b*) a normal salt of a dibasic acid, containing pseudo-divalent mercury—

$$\left\{\begin{array}{l} (CH_3)_2COHg'',\ OK \\ \quad\;\, | \\ \quad HgO \\ \quad\;\, | \\ (CH_3)_2COHg'',\ OK \end{array}\right.$$

While the normal barium and potassium salts of the tetrabasic acid have, I venture to think, been distinctly made out, I am unable to offer any satisfactory evidence of the existence of some of those compounds just referred to. I should add, however, that I am warranted on experimental grounds in suggesting the probable existence of these bodies; but the difficulties attending the separation and purification of such ill-defined compounds have been sufficient to hitherto prevent their isolation in a state suitable for analysis.

XIII.—*An Inquiry into the Cause of the Interrupted Spectra of Gases; Part II. On the Absorption Spectrum of Chlorochromic Anhydride*. By G. JOHNSTONE STONEY, M.A., F.R.S., Secretary to the Queen's University in Ireland; and J. EMERSON REYNOLDS, M.R.C.P.E., Keeper of the Mineral Department, and Analyst to the Royal Dublin Society.

[Read February 20, 1871.]

ABSTRACT.

ONE of the authors of this communication recently published* an investigation into the cause of the lines which present themselves in the spectra of gases, in which he traced the origin of these lines to periodic motions in the molecules of the gas, and showed that usually several lines in the spectrum will arise out of each such motion.

It follows, in fact, from the investigation to which we refer, that in all the cases in which the periodic motion in the gas produces an undulation in the æther, consisting of waves of any other kind than simple pendulous vibrations, there must be a resolution of the undulation into its pendulous components, when it enters a dispersing medium; and it further appears that the periodic times of these component waves must be either the periodic time of the parent motion, or harmonics of it. It is these pendulous components which present themselves as lines in the spectrum. The way in which the intensities of the lines depend on the character of the original disturbance was also pointed out.

We wished to apply this theory to the study of the spectra of particular gases; both in order to test the theory, and to make use of it for the investigation of the motions which take place within the molecules of matter, about which but little is yet understood. We had, however, no opportunity of carrying out our intention until the construction of the great Grubb spectroscope of the Royal Dublin Society was so far advanced that we could employ it, which was in January last; since which time the following investigation has been made in the laboratory of the Society:—

When a column of the brown vapour of chlorochromic anhydride is interposed between a source of light and the eye, certain of the rays are intercepted, and the deep colour of the vapour is due to this suppression of some of the tints. When the light that is used is sufficiently bright it is possible by the spectroscope to determine precisely what rays are absorbed; for to each intercepted ray there will correspond a dark line in the spectrum. In this way we find that the vapour of chlorochromic anhydride absorbs very little of the red, while it entirely obliterates the

* "Report of the British Association for 1870," p. 41; "Proceedings of the Royal Irish Academy" of January 9th, 1871; "Philosophical Magazine," vol. xli. (1871), p. 292.

other end of the spectrum, shutting out the blue, indigo, and violet; and that in the interval between these two regions, extending over the orange, yellow, and green, there are about 120 or 130 lines. We have measured the positions of thirty-one of these lines, distributed irregularly over nearly the whole of this range. In doing so, we selected those of which the positions could be determined accurately with the most ease, and in every one of these cases the position of the line was found to be that which our theory assigns to it. The theory is therefore satisfactorily verified.

It is accordingly safe to employ this theory; and we have by it been able to ascertain that the whole of this long series of lines is due to a single motion in the molecules of the vapour. We have moreover found the periodic time of this motion, which is $\frac{T}{2 \cdot 7}$, where T is the time which light takes to advance one millimetre. This determination cannot be in error by more than one five-hundredth part of its amount; and it indicates that this tiny motion is executed rather more than 800,000,000,000 (eight hundred thousand millions) of times in each molecule of this vapour every second of time.

We have also been able to extract some information about the character of the motion, from the succession of intensities of the lines in the spectrum; but our knowledge on this subject is as yet imperfect. The motion seems to be of a kind which bears a curious relation to the motion of a certain point upon a violin string while the bow is being drawn—viz., a point that lies at a distance of nearly but not quite two-fifths of the length of the string from one end.

The foregoing investigation has been made with the spectroscope and appliances of the Royal Dublin Society, which are adapted for the examination of absorption spectra and of the spectra of such vapours as are incandescent at moderate temperatures. We hope soon to be able to include in our inquiry the many gases that require the temperature of the electric spark to render them incandescent, by the help of additional apparatus which the Royal Irish Academy is supplying to us.

XIV.—*Mineralogical Tables, arranged with a view to facilitate the Examination of the Mineral Collection of the Royal Dublin Society.* By J. EMERSON REYNOLDS, M. R. C. P. Edin., Keeper of the Mineral Department, and Analyst to the Royal Dublin Society.

[Read November 21, 1870.]

INTRODUCTION.

As the valuable and extensive mineral collection of the Royal Dublin Society has lately undergone re-arrangement, the time seemed favour-

able for the publication of an outline of the classification employed, which should serve also as a guide to students in the examination of the series of specimens exhibited. In drawing up such a guide it seemed desirable to depart from the usual practice in such cases, and supply a certain amount of information about most of the mineral species placed in the Museum. In carrying out this intention it was found most convenient to adopt a tabular arrangement, and to include under the heads of the Crystalline form, Chemical composition, Lustre and Colour, Hardness and Specific Gravity, the more prominent characters, each serving, in a greater or less degree, for the identification of the minerals whose names find a place in this work. It should be added, however, that the list does not contain the names of many varieties or species of subordinate interest, specimens of which are exhibited in the collection. On the other hand, in some very rare instances, the name and characters of a mineral are given in the Tables though no specimen is at present shown; but it seemed undesirable to publish a list without including the species referred to.

The mineral collection is contained in a series of 43 cases, arranged on the second gallery of the Chief Hall of the Natural History Museum. On a platform at the western end of the gallery are placed three large and two smaller table cases; one of the latter contains a collection of coals and allied carbonaceous mineral mixtures; the remaining four cases being filled with specimens of the unoxidised chemical substances other than the Salts of the Halogens—Chlorine, Iodine, Bromine, and Fluorine; while the collection of Meteorites finds a place in an upright compartment. The remaining 38 cases are placed round the gallery, and, with the exception of Nos. 6 and 7, which contain the Chlorides, Iodides, Bromides, and Fluorides, all the minerals exhibited in these are compounds of which Oxygen is an essential constituent.

The plan adopted in the subdivision of the three great classes of bodies above mentioned will be evident on inspection of the Tables, but some of the chief groups of minerals in each class and species of industrial importance may be here briefly indicated:—

I. In the first subdivision of the class are placed the elementary chemical substances found native in a more or less pure condition. The noble metals—Gold, Silver, and Platinum—may be given as examples of these, together with the delicately-coloured unmetallic mineral Sulphur, and Carbon, in its three widely-differing conditions of Graphite (the so-called Black Lead), the magnificent mineral Diamond, and the coal-like Anthracite. Amongst the compounds of the metals with Sulphur, Arsenic, &c., the most remarkable are the valuable ores of Silver, Glance Silver, the Red Silvers—Proustite and Pyrargyrite, Brittle Silver Ore, and the argentiferous variety of Fahlerz. In this class we also have the valuable ore Galena, the Sulphide of Lead; the rich Copper-bearing minerals Glance-Copper, Bornite, Copper Pyrites, and the Grey or "Fahlerz," of the German miners. Some large specimens of the last mineral, found at Liskeard, Cornwall, exhibit a very beautiful iridescence. The mineral Stibnite, the chief source of the metal Antimony, occurs here;

and into this class also fall the well-known Iron Pyrites, from which the Sulphur used in the manufacture of Sulphuric Acid, or Oil of Vitriol, is largely derived; the Arsenical Pyrites and the valuable Arsenides and Sulpharsenides of Nickel and Cobalt; the Sulphide of Zinc or Blende, and Cinnabar, the source of the metal Mercury, or Quicksilver.

II. In the second class, the compounds of the four Halogens find their place. Rock Salt, or Chloride of Sodium, and the variously-coloured and often beautiful Mineral Fluor Spar, or Fluoride of Calcium, are the most remarkable members of this class; but, in addition to these, the valuable Chloride, Iodide, and Bromide of Silver are worthy of notice; and the fine Cryolite, or Ice Stone, the double Fluoride of Aluminium and Sodium, from which the metal Aluminium is extracted. This mineral was discovered in Greenland by the late Sir Charles Giesécke, the former Keeper of the Mineral Collection of the Royal Dublin Society.

III. The third class includes an immense number of minerals, many of which are of industrial importance. Generally, the members may be divided into four sections. (*a*) Basic Oxides,* (*b*) Indifferent Oxides, (*c*) Acidifiable Oxides, and (*d*) Salts.

(*a*). This section includes the valuable Suboxide, or Ruby Copper; the great ore of Iron Red Hæmatite, (a Sesquioxide), its varieties, and the allied hydrated Brown Hæmatites; also the Sesquioxide of Aluminium in its widely-differing forms of Emery, Corundum, and the exquisitely-coloured varieties, Oriental Sapphire, Ruby, Amethyst, Emerald, &c.

(*b*). One of the most remarkable of the Indifferent Oxides is the Manganese Binoxide, or Pyrolusite, so largely employed in the preparation of Chlorine from Hydrochloric acid for the manufacture of bleaching powder. A group of minerals called Spinelles occur in this section, the typical member of the group furnishing some beautifully-coloured varieties, the Balas Ruby, Rubicelle, &c. Another member of the group, Chrysoberyl, is likewise used for ornamental purposes. The valuable Magnetic Iron ore is also a Spinelle, and the Chrome Iron ore—the chief source of Chromium compounds in the Arts.

(*c*). In the section of Acidifiable Oxides we find Tinstone (the Binoxide), the great ore of Tin, and several much less important metallic oxides. The most widely-distributed mineral of the group—Silica—is the Binoxide of Silicon. Its numerous varieties from the perfectly-formed Rock Crystal and the variously-coloured crystallised Quartz, to the non-crystalline Calcedony, Agate, Jasper, &c. and the hydrated Opal, includes some of the best-known and most attractive minerals, many of them being extensively employed in jewellery. Quartz, in the form of fine white sand, is the principal material used in the glass manufacture, the varieties of window,

* In the Tables, however, the chemical formula is used to determine the subdivision of the Oxides and Salts.

crown, flint, and other kinds of glass resulting from the fusion of Silica or Quartz with certain of the basic oxides, lime, oxide of lead, soda, potash, or a mixture of these in suitable proportions.

(*d*). In the first section of the group of Salts are placed the Silicates, the native compounds resulting from the union of Silica with metallic oxides. The Silicates may be further subdivided into groups of minerals resembling each other in form, chemical composition, or mode of occurrence in nature. Seven such groups may be conveniently recognised: these are the Felspar, Mica, Garnet, Hornblende, Serpentine, Zeolite, and Andalusite groups; the name of the typical mineral round which the other Silicates are gathered serving usually to distinguish the group. The Salts derived from other acids follow the Silicates in their natural order, and some of the more remarkable of these are briefly referred to in the following paragraphs.

Considering the Silicates in the order just given we meet first with the Moonstone—a white, translucent, and impure variety of Orthoclase or potash felspar—which is prized as an ornament in Eastern countries. The common variety of felspar, when sufficiently free from colouring oxides, is used as a glaze for porcelain, the latter substance being made with a fine white clay which is a product of decomposition of minerals for the most part belonging to the Felspar group. Associated with this group are the Lapis Lazuli, or native Ultramarine, and the Beryl, the green and blue varieties of which latter are respectively well known as the richly-coloured Emerald and the Aquamarine.

The Micas constitute a remarkable group of minerals, chiefly characterised by the facility with which they can be cleaved into thin flexible plates. The colourless, transparent varieties were at one time used in lieu of glass for windows. All granites contain a Mica as an essential constituent.

The most striking member of the next group is the precious Garnet, which is employed in the cheaper kinds of jewellery. The Hornblendic minerals are chiefly interesting from a chemico-geological point of view; but certain of the Serpentines, more especially the varieties of precious Serpentine—a hydrated magnesian Silicate coloured with various metallic oxides—are of considerable commercial value, owing to their use for decorative purposes; and several of the mineral mixtures included under the general head of Clays find many useful applications in the Arts—amongst others, to the manufacture of porcelain, pottery of various kinds, and bricks.

The beautiful Zeolite group does not afford any minerals of practical importance; but in the Andalusite series is found the Boro-Silicate Tourmaline, the delicate pink variety of which constitutes the very costly mineral Rubellite. The well-known Topaz, a silico-fluoride of aluminium also occurs in this group, and is a mineral of considerable value, when perfectly transparent, and possessing a rich yellow or a pink colour.

Amongst the Borates the only minerals of practical importance are

the crude Boracic acid and Borax, the anhydro-borate of sodium. The groups of Chromates, Tantalates, Tungstates, Titanates, Molybdates, &c., include few minerals of commercial value, though many of high scientific interest. The same statement may be made respecting the Vanadiates and Arseniates, but in the group of Phosphates we find the numerous varieties of mineral Phosphate of Calcium—Apatite—which have of late years attracted an extraordinary amount of attention, owing to the greatly increased use of the artificial Phosphatic manures largely manufactured from them. Pyromorphite, the phosphato-chloride of Lead, is also a mineral of some importance, when occurring in nature in any considerable quantity, as well as Vivianite, the blue hydrated ferrous phosphate. The delicately-coloured and often beautiful gem Turquois also belongs to this group, being a hydrous aluminic phosphate tinted usually with copper.

The series of Sulphates includes several well-known minerals, amongst others the Heavy Spar—barium sulphate—frequently accompanying metallic veins; Anglesite, the lead sulphate; and the three varieties of hydrated calcium sulphate—Selenite, in transparent crystals with eminently-foliated structure, the satin-like Fibrous Gypsum, and the well known Alabaster—the fine-grained translucent variety employed for ornamental purposes. The crude forms of the mineral are much used in agriculture, and the white gypsum, when heated so as to drive off the combined water, constitutes the "Plaster of Paris" of commerce.

Amongst the Carbonates we also find a considerable number of important minerals. The most remarkable is the Calcium Carbonate in its extremely varied and often fantastic forms; the somewhat impure massive varieties of the mineral, the "Limestones," afford when strongly heated the well known "Quicklime," which serves so many valuable purposes in the arts; while in the unaltered state, as chalk, whiting, &c., the uses to which the mineral is applied are numerous and varied. From Dolomite, Magnesic and Calcic Carbonate, and Magnesite, Magnesic Carbonate, the chief commercial supplies of Magnesian Salts are drawn; and the Lead and Zinc Carbonates named severally Cerussite and Smithsonite are valuable and convenient sources of the respective metals when occurring in quantity. One of the most important minerals of the group is, however, the Ferrous Carbonate, or Siderite; in its impure earthy form it constitutes one of the varieties of Clay Ironstone used in the manufacture of metallic Iron. From Malachite and Azurite, the beautiful basic Copper Carbonates, the important metal which they contain can be easily extracted. Malachite possesses additional interest owing to its employment for ornamental purposes.

The small group of Nitrates form the connecting link between ordinary minerals and those which, like Mellite and the Oxalite, are directly traceable to the decomposition of organised carbon compounds. The Nitrates, though containing no carbon, are chiefly produced in nature by the oxidation of nitrogenised carbon compounds. The most important mineral of the series is the Sodium Nitrate, which, under the name of

"Chili Nitre," is used in enormous quantities in the manufacture of Oil of Vitriol.

If, for practical purposes, we define a "Mineral" as being *a homogeneous, unorganised, naturally occurring substance, possessing, when in a pure state, a distinguishing group of chemical and physical characters*, it will be easily seen that the number of "Organic Minerals" which can be admitted to a place in the Tables must be very limited, and in fact this is so far true that all indefinite mixtures of hydro-carbons and of oxygenated organic compounds have been excluded from the list; hence, only bodies like Mellite and Oxalite find a place in the series. It is scarcely necessary to add that the Coals, if regarded as more or less impure varieties of Carbon, might be most naturally associated with the group of native elementary chemical substances.

EXPLANATION OF TABLES.

Crystalline Form.

In the left-hand column of each table the Crystalline system to which a mineral belongs is stated. As the terms 1st, 2nd, &c., only are employed, it is necessary to define their meaning:—

1st System.—	Crystals having three equal axes at right angles.
2nd "	Three axes at right angles, two of them equal.
Hexagonal	Four axes, three being of the same length, lying in the same plane and equally inclined, the fourth making a right angle with the plane of the other three.
4th "	Three axes, all unequal and at right angles.
5th "	Three axes, two at right angles, and the third inclined to their plane.
6th "	Three axes, all inclined.

Chemical Composition.

The chemical composition is expressed as far as possible by formulæ which in almost all cases have been carefully recalculated from the most recent analyses of the several minerals. The new atomic weights of the elements have been employed in these calculations.

In the formulæ, the "quantivalence" of the elements is frequently marked, and in certain of the formulæ, the monad, dyad, triad, or pseudotriad, and tetrad constituents are, for the sake of convenience, sometimes bracketed together—one atom of a tetrad being, of course, regarded as equal, chemically, to two atoms of a dyad, or four of a monad element.

In writing the formulæ of compounds of more or less distinctly marked saline constitution, I have partially employed a construction which I proposed in a paper *On the Silicic Acids and the Anhydrous Mineral Silicates.* (Philosophical Magazine, Vol. xxxvi., p. 274.) Thus Spinelle is written—

$$Mg\,\frac{Al^{vi}_2}{O_3}O.$$

Magnetic Iron Ore—

$$Fe''\,\frac{Fe^{vi}_2}{O_3}O.$$

Willemite—

$$Zn''_2 \frac{Si}{O_2} O_2$$

and Orthoclase—

$$K'_2\, Al^{vi}_2 \frac{S}{O_{12}} O_4$$

This modified water type construction has been adopted for reasons which are explained in the paper above referred to, and the convenience resulting from its use will be apparent on examination of the formulæ given in the Tables, more particularly those of the Sulpho-Salts, Silicates, Phosphates, and Arseniates. In these formulæ Sulphur, Oxygen, &c., are supposed as usual to act in holding together the molecular edifice, but the well-known "Oxygen ratio" which mineralogists have been long accustomed to use is still exhibited in each case by the construction adopted, and, in addition, certain of the high temperature modes of decomposition or recomposition of some of the minerals are indicated.

Lustre, Colour, &c.

In the fourth column in each Table the kind of lustre and colour of each mineral is usually stated, and any strongly marked peculiarity in character or in mode of occurrence noted.

The abbreviations used to indicate lustre are the following:—M. L., Metallic Lustre; B. M. L., Bright Metallic Lustre; S. M. L., Sub-Metallic Lustre; M. A. L., Metallic Adamantine Lustre; A. L., Adamantine Lustre; V. L., Vitreous Lustre; P. L., Pearly Lustre; R. L., Resinous Lustre; G. L., Greasy Lustre; S. L., Silken Lustre.

The degree in which a mineral transmits light is sufficiently indicated by the terms transparent, translucent, or opaque.

Degree of Hardness.

The hardness of a mineral is measured by its power of resisting a scratch with the nail, a file or a harder substance. As minerals vary greatly in their power of resisting abrasion, Mohs constructed the following scale of hardness, which is that employed in the Tables; talc being most easily scratched and the diamond resisting impression completely:—

1. Talc, foliated.
2. Rock Salt; or better crystallised Gypsum.
3. Calc Spar, transparent.
4. Fluor Spar, crystallised.
5. Apatite, transparent.
6. Orthoclase Felspar.
7. Quartz, transparent.
8. Topaz, transparent.
9. Corundum, transparent.
10. Diamond.

Specific Gravity.

In the last column the average Specific Gravity of each mineral is given, water at the standard temperature being taken as unity.

ELEMENTARY BODIES OCCURRING IN THE FREE STATE.

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
1st. Octohedra.	Gold, . . .	Au Some specimens of native gold contain as much as 60 per cent. of silver with a little Cu and Fe.	M. L. Yellow, . .	2·5	16–19·3
1st. Oct. mod.	Silver, . .	Ag Native silver usually contains Au, Sb, Cu; sometimes Hg and Bi.	M. L. Bright white Occurs usually in fibrous masses,	2·5	10–11
1st. Cubic,	Platinum, .	Pt Associated with Ir, Ru, Os, Rh, Pd, Fe, and other metals.	M. L. Steel-gray,	4·	16–19
1st. Oct.	Palladium,.	Pd	M. L. Steel-gray,	4·5	12
	3rd. *Allopalladium*, dimorphous form,	"			
1st. Oct. below —39 F.	Mercury, .	Hg	M. L. Grayish-white in globules,	0 at ordinary temperature.	13·5
1st. Oct. mod.	Copper, . .	Cu Native copper usually contains Fe and Ag.	M. L. Red, . . .	2·5	8-9
1st.? Oct.	Iron, . . . a. *Telluric* in basalt, b. Meteoric,	Fe Meteoric Iron contains much nickel, and traces of other metals; also P, S, and C.	M. L. Dark-gray. When a polished surface of meteoric iron is treated with an acid, Fe is dissolved, and a crystalline alloy of Fe and Ni left. The peculiar structure developed is called Widmannstätten pattern.	4·5	7-7·8

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
1st.	Lead, . . .	Pb	M. L. Bluish-gray, in lamellæ,	1·5	11·4
3rd. Rh.	Arsenic, . .	As	Sub. M. Gray-white,	3·5	5·9
3rd. Rh.	Antimony, .	Sb	M. L. Tin-white,	3·5	6·7
3rd. .	Bismuth, .	Bi	M. L. Grayish-white with red shade,	2·5	9·72
3rd.	Tellurium, .	Te ?	M. L. Tin-white,	2·5	6·2
"	Zinc, . . .	Zn ?	?	?	?
4th.	Tin, . . .	Sn ?	?	?	?
"	Sulphur, .	S	A. L. Yellow, .	2·0	2·07
Oct. mod.	*Var. Selen. sulphur,* . . .	S with Se	R. L. Brownish, .		
—	Carbon, . .	C			
1st. Tetra, or Oct. mod.	*Var. Diamond,*	"	Brilliant lustre, colourless, or variously tinged by impurities,	10·0	3·55
3rd. Prismatic,	*Graphite,*	Usually contains a little Fe	M. L. Deep Grayish-black,	1–2	2·2
Non-Crystall.	*Anthracite, Jet.*	Some varieties nearly pure Carbon,	S. M. L. Deep black,	2–2·5	1·5
Appendix to Group.					
1st. Dod. mod.	Silver Amalgam,	Ag Hg, nearly,	M. L. White, . .	3·0	10-14
	Gold Amalgam,	Au_2Hg_3 nearly,	M. L. Yellowish-white,	—	3
1st. Cubic mod.	Platiniridium,	Pt and Ir, variable,	M. L. Whitish, usually in grains,	7	22·8
3rd. Prismatic,	Iridosmine,	Ir. and Os, variable,	M. L. Tin-white, usually in grains,	7	20–21·1
3rd. Rh.	Allemontite, *(Arsenical Antimony,)*	$SbAs_3$.	M. L. Bright gray, usually massive,	3·5	6·2

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
4th. Prismatic,	**Discrasite,** (Antimonial Silver),	Ag_3 Sb, variable,	M. L. Silver-white,	3·5	9·5
Massive,	**Domeykite,**	Cu''_3 As.	M. L. Yellowish-white,	3·5	4·5
"	**Condurrite,**	The last partially oxidized,	Brownish-black, sometimes bluish,	3·0	4·3

TELLURIDES.

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
1st. Cubic,	**Altaite,** . .	PbTe.	M. L. Tin-white, with yellowish tarnish, . . .	3	8·10
2nd. Flattened prisms,	**Nagyagite,** *Syn.* Black Tellurium,	(PbAu) (S Te)$_3$ (probably),	M. L. Leaden-gray, in flexible laminæ,	1·5	6·6
4th. Prismatic,	**Sylvanite,** . *Syn.* White or graphic Tellurium,	—(Au Ag) Te_2.	M. L. Tin-white, crystals arranged in groups, . .	2	8
4th, "	**Hessite,** . . Var. *Petzite,* .	Ag_2Te. Contains about 25 per cent of Au. sometimes.	M. L. Iron-gray, .	3	8·4
3rd.	**Tetradymite,**	Bi_2Te_3; contains a little S.	M. L. Steel-gray, in laminæ often,	2	7·6

SULPHIDES, ARSENIDES, &c.

Mono-Sulphides,—Arsenides, &c.

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
—	**Sulphuretted Hydrogen,**	H_2S.	Colourless gas, with offensive odour.		1.171 Air=1
1st. Cubic mod.	**Galena,** . .	PbS.	M. L. Leaden-gray,	3·	7·5
1st.	**Silver Glance** (Vitreous Silver),	Ag_2S.	M. L. Gray-black,	2·5	7·2

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
	Var. *4th. Acanthite,* in prisms modified,	Ag_2S			
1st. Tetra.	Blende, . . *Syn.* Black Jack, *Var.* *Wurtzite* occurs in hex. prisms.	ZnS. Same,	S. M. R. Yellow to Brownish-black.	3·5	4·0
1st. Cubic mod. oct.	Mangan-blende, *Syn.* Alabandine,	MnS.	S. M. L. Black, .	4·0	4·0
Massive,	Kaneite, . .	$Mn''As$. ?			
Massive,	Syepoorite,	CoS.	Gray, ...		5·45
1st. Oct.	Eisennickelkies,	—$(Ni,Fe)''S$.	M. L. Bronze-yellow,	4	4·6
1st. Cubic,	Clausthalite,	PbSe.	M. L. Darker than galena, usually massive.	2·5	8·0
1st.	Berzelianite,	Cu_2Se.	M. L. Silver-white.		
,,	Naumannite,	Ag_2Se.	B. M. L. Iron-gray, often in plates,	2·5	8·0
?	Eucairite, .	(Ag_2Cu_2) Se.	Similar to above, usually granular.		
?	Crookesite,	(Cu_2, Tl_2, Ag_2) Se.	M. L. Leaden-gray,	3	6·90
1st. Oct. mod.	Erubescite, *Syn.* Purple or Horseflesh copper, Bornite,	$(Cu_2Fe)S$.	M. L. Reddish-Brown, often with purple tarnish.	3·0	5·0
4th. Oc. mod.	Copper Glance, *Syn.* Vitreous Copper, Chalcocite,	Cu_2S.	M. L. Dark leaden-gray, Usually massive.	3 nearly	5·5

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
4th.	Stromeyerite,	$(Cu_2Ag_2)S$,	M. L. Steel-gray,	2·5	6·2
,,	Sternbergite (Flexible silver ore),	$(FeAg_2)S$. ?	M. L. Brownish, often occurs in groups of flexible plates,	1·0	4·2
3rd. Rh.	Cinnabar, .	HgS.	M. L. Reddish-brown, or bright red when earthy,	2·5	9·0 nearly
3rd. Prism. mod.	Greenockite,	CdS.	A. L. Transparent yellow,	3·5	4·9
3rd. Rh.	Millerite, .	NiS.	M. L. Bronze-yellow,	3·5	5·0
3rd. Prismatic,	Kupfernickel,	NiAs.	M. L. Pale copper colour, usually massive,	5·5	7 0
3rd.	Breithauptite,	NiSb	B. M. L. Reddish, with violet shade; often in plates,	5·5	7·5
,,	Covellite (Indigo copper),	Cu''S.	S. M. L. Rich Indigo-blue; usually massive.	1·5	4 6
Prismatic,	Pyrrhotite, *Syn.* Magnetic Pyrites,	Fe_7S_8.	M. L. Bronze-yellow; magnetic,	4·0	4·5
?	Troilite, .	FeS.	M. L. Brown, only occurs in meteorites, massive,	4·0	4·5
?	Schreibersite,	Phosphide of Fe and Ni.	M. L. Steel-gray, granular and foliated, magnetic,	6 5	7·1
5th. Prismatic,	Realgar, .	AsS.	R. L. Full orange,	1·5	3·5
Sesquisulphides.					
4th.	Orpiment, .	As_2S_3.	R. L. Yellow, usually foliated,	1·5	3 4
,,	*Var. Dimorphite.*	As_4S_3.			

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
4th.	Stibnite,. . *Syn.* Gray Antimony,	Sb_2S_3.	M. L. Bright leaden gray. In radiating masses,	2·0	4·5
5th. Prismatic,	Kermesite,	$Sb_2(SO)_3$	S. M. L. Deep red. Often in groups of crystals.	1·5	4·5
4th. Prismatic,	Bismuthite,	Bi_2S_3.	M. L. Leaden-gray, in long crystals,	2·0	6·5

Di-Sulphides and Diarsenides.

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
3rd.	Molybdenite,	MoS_2	M. L. Leaden-gray; massive usually,	1·0	4·5
1st. Oct.	Hauerite, .	MnS_2	M. L. Reddish-brown,	4·0	3·4
1st. and 4th.	Iron Pyrites, *Var.*	FeS_2	B. M. L. Pale yellow,	6·0	5·0
	1*st.* *Common or cubic pyrites,*	,,	Often granular. Very slowly oxidized by exposure to air,		
	4*th.* *Marcasite, rhombic or cockscomb pyrites,*	,,	M. L. Very pale yellow; occurring in compound tabular crystals, easily oxidized by exposure to air,	6·0	4·6
4th.	Leucopyrite,	$FeAs_2$	M. L. Steel-gray,	5·0	7·5
,,	Rammelsbergite,	$NiAs_2$	Closely resembles last,	5·5	7·1
1st.	Chloanthite, *Syn.* White nickel,	$NiAs_2$			
,,	Eisenkobaltnickelerz,	$(Fe,Co,Ni)\ As_2$	All—M. L. Tin-white or gray,	5·5	6·8
,,	Smaltine, *Syn.* Tin-white or gray cobalt,	$CoAs_2$			

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
4th.	**Mispickel**, .	$Fe\ (SAs.)_2$	M. L. Grayish-white.	5·5	6·3
"	**Glaucodote**,	$(Fe, Co)\ (SAs)_2$	M. L. Whiter than last.	5	6
1st.	**Cobalt-glance**, *Syn.* Cobaltine, Silver-white cobalt,	$Co\ (SAs)_2$	M. L. Silver-white.	5·5	6·2
"	**Nickel-glance**, *Syn.* Gersdorffite,	$Ni\ (SAs)_2$	M. L. Silver-white.	5·5	6·2
"	**Ullmannite**, *Syn.* Nickeliferous gray Antimony,	$Ni\ (SSbAs)_2$	M. L. Silver-white.	5·5	6·3

Sulpho-Salts.

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
1st.	**Cobalt pyrites**, *Syn.* Linneite,	$Co^2 \frac{Co}{S_2} S_2$ or $(Co,Ni,Cu)_2 \frac{Co}{S_2} S_2$	M. L. Steel-gray.	5·5	5·0
2nd. Tetra.	**Tin pyrites**,	$(Cu,Fe,Zn)^2 \frac{Sn}{S_2} S_2$	M. L. Dark or yellowish gray; usually massive.	4·0	4·2
2nd.	**Copper pyrites**, *Syn.* Chalcopyrites, Towanite,	$Cu_2 \frac{Fe_2}{S_3} S$	M. L. Yellow.	4·0	4·2
2nd. Tetra.	**Tetrahedrite**, *Syn.* Fahlerz, gray copper ore, *Var. Kupferfahlerz, Silberfahlerz, Quecksilberfahlerz*,	$(Cu,R)^4 \frac{(SbAs)^2}{S_3} S_4$	M. L. Dull-gray. Some varieties exhibit beautiful iridescent tarnish.	About 4·0	from 4·5 to 5·8

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
2nd.	Tennantite,	$(Cu,Fe)^4 \frac{As^2}{S_3} S_4$	M. L. Deep grayish-black.	3·5	4·5
4th.	Wolfsbergite, *Syn.* Antimonial copper,	$Cu^2 \frac{Sb^2}{S_3} S$	M. L. Black.	3·5	5·0
"	Aikenite, *Syn.* Needle ore,	$(CuPb)^2 \frac{Bi^2}{S^3} S^3$	M. L. Dark gray.	2·5	6·4
"	Bournonite,	$(CuPb)^3 \frac{Sb^2}{S_3} S_3$	B. M. L. Leaden.	3·0	5·8
"	Berthierite,	$Fe \frac{Sb_2}{S_3} S$	M. L. Dull gray.	2·5	4·2
?	Sartorite, .	$Pb \frac{As^2}{S_3} S$	M. L. Dull gray.	3·0	5·393
"	Zinkenite, .	$Pb \frac{Sb^2}{S_3} S$	M. L. Steel gray.	3·5	5·3
6th.	Freislebenite,	$(Pb,Ag_2)^2 \frac{Sb^2}{S_3} S_2$	M. L. Steel gray.	2·5	6·2
4th.	Dufrenoysite,	$Pb^2 \frac{As^2}{S_3} S^2$	M. L. Very dark gray.	3·0	5·5
"	Jamesonite, Syn. Feather ore,	$(Pb,Fe)^2 \frac{Sb^2}{S_3} S^2$	M. L. Steel gray.	2·5	5·5
?	Boulangerite,	$Pb^3 \frac{Sb^2}{S^3} S^3$	M. L. Steel gray.	2·0	5·8
?	Kobellite, .	$Pb^3 \frac{(Bi,Sb)^2}{S^3} S^3$	M. L. Bright deep gray.		6·3
5th.	Meneghenite,	$Pb^4 \frac{Sb^2}{S^3} S_4$	V. B. M. L. Steel-gray.	2·5	6·3
4th.	Geocronite,	$Pb^5 \frac{(Sb,As)^2}{S_3} S^5$	M. L. Like Galena.	2·5	6·5

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
?	Kilbrickenite,	$Pb^6\frac{Sb^2}{S^3}S^6$	As last.		
5th.	Miargyrite,	$Ag^2\frac{Sb^2}{S^3}S$	S.—M. L. Dull black.	2·5	5·3
3rd.	Pyrargyrite, *Syn.* Dark red silver ore,	$Ag^6\frac{Sb^2}{S^3}S^3$	M. L. Very deep red.	2·5	5·8
"	Proustite, *Syn.* Light red silver ore,	$Ag^6\frac{As^2}{S^3}S^6$	A. L. Deep red.	2·5	5·5
4th.	Stephanite, *Syn.* Brittle silver ore,	$Ag^{10}\frac{Sb^2}{S_3}S_3$	M. L. Dull black.	2·5	6·26
"	Polybasite,	$(Cu''Ag^2)_9\frac{(SbAs)^2}{S^3}S^9$	M. L. Black.	2·5	6·2

CHLORIDES, BROMIDES, AND IODIDES.

1st.	Rock Salt, .	Na Cl	V. L. White, colourless, reddish, or bluish.	2·0	2·15
"	Sylvite, . .	K Cl	V. L. White, colourless.	2·0	2·0
"	Sal Ammoniac,	NH_4 Cl	V. L. White.	1·4	1·52
"	Horn Silver, *Syn.* Kerargyrite,	Ag Cl	R. L. Pearl gray after exposure to light, colourless or yellowish before, usually.	1·4	5·43
"	Embolite, . .	Ag (Cl,Br)	R. L. Greenish, dull, discoloured by action of light.	1·4	5·5
"	Bromyrite,.	AgBr	B. L. Full yellow with greenish shade, discoloured by light.	2·5	5·9

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
2nd.	Calomel, . . *Syn.* Horn Mercury,	Hg_2Cl_2	A. L. Yellowish-gray.	1·5	6·48
3rd.	Iodyrite, .	Ag I	R. L. Yellow, discoloured by light.	1·5	5·6
4th.	Cotunnite, .	$PbCl_2$	White.	1·5	5·23
Massive,	Carnallite, .	$(K_2,Mg)\,Cl_2 + 4\,H_2O$	S.L. White or reddish.	·32	?

Oxychlorides.

2nd.	Matlockite,	$PbCl_2 + PbO$	A. L. Transparent, with yellow tinge, crystals tabular.	3	7·21
4th.	Mendipite, .	$PbCl_2 + 2\,PbO$	P.L. White, opaque, variously tinged, often in radiating fibrous tufts.	3	7·1
,,	Atacamite, .	$CuCl_2 + 8CuH_2O_2 + H_2O$	A. L. Bright green, often in grains or lamellæ.	3·5	4·2
3rd.	Connellite, .	Hydrous chloride and sulphate of copper.	V. L. Blue, occurs in long thin prisms.	—	—

FLUORIDES.

1st.	Fluor Spar,	CaF_2	V. L. Variously coloured, most commonly of bluish shades, often fluorescent.	4·0	3·2
3rd.	Fluo-cerite,	$Ce\frac{Ce^2}{F_6}F_2$	S. A. L. Reddish-yellow, often in laminæ.	4·5	4·7
Massive,	Yttro-cerite,	$(Ca, Ce, Y)F_2$?	P. L. Violet blue.	4·5	3·44
4th.	Fluellite, .	Al and F in unknown proportions,	V. L. White.	3·0	
2nd.	Chiolite, . .	$Na^3\frac{Al_2}{F_6}F^3$	R. L. Pure white.	4·0	2·72

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
4th. ?	Cryolite, . .	$Na^6 \frac{Al_2}{F_6} F^6$	V. L. Snow white, often discoloured by impurities; usually reddish.	2·5	3·0
"	Altered to *Pachnolite*, .	Same with Ca and H^2O			

OXIDES.

Sub–Oxides, Monoxides and Derived Hydroxides.

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
1st. In Oct.	**Red copper ore,**	Cu_2O	S-m. L. Red.	3·5	6·0
	Var. *Ruby copper,*	"	Deep red.		
	Chalcotrichite,	"	Red, with violet shades, occurs in fine needles.		
"	*Tile ore,*	Contains much Fe_2O_3	Dull red, or brownish, massive, earthy.		
1st.	**Black copper ore,**	CuO	S-m. L. Dark steel-gray, massive, earthy.	3·0	6·25
"	**Periclase,** .	MgO	D. L. Dull-greenish, often granular.	5·5	3·67
3rd.	**Brucite,** foliated var. *Nemalite* when fibrous,	MgH_2O_2	P. L. White.	1·5	2·35
"	**Ice,** . . . . *Var.* *Water,*	H_2O	V. L. Colourless or white, liquid above O°C.		·918
"	**Spartalite,** *Syn.* Red Zinc ore,	ZnO Coloured by Mn_2O_3	S-a. L. Deep red. Subtransparent.	4·0	5·5
4th.	**Massicot,** .	PbO	D. L. Yellow.	2·0	7·88

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
Sesquioxides and derived Hydroxides.					
Hex.	Corundum, *Var.* *a. Coloured transparent.* *Oriental Sapphire,* ,, *Amethyst,* ,, *Emerald,* ,, *Ruby,* ,, *Topaz,*	Al_2O_3 Variously coloured by traces of metallic oxides,	V. L. Blue. Violet. Green. Purple red. Yellow.	9·0	4
	(*b.*) Corundum,		Colourless or bluish.		
	(*c.*) Emery,		Dull brownish earthy.		
5th.	Gibbsite, (Stalactitic), *Var.* Crystallized, called *Hydrargillite,*	$Al_2H_6O_6$	D. L. White, yellowish, or greenish.	3	2·35
4th.	Diaspore, (Oolitic and ferruginous variety, called *Beauxite*),	$Al_2H_2O_4$	B. L. Often greenish-gray; resembles talc; variously coloured.	7·0	3·4
Hex.	Hematite, *Red,* *Var.*	Fe_2O_3			
	(*a.*) *Fibrous Red Hematite,*		S. M. L. Brown, or nearly black.	6·0	5·0
	(*b. Specular or micaceous,*		B. M. L. Iron black, in distinct crystals or laminæ.		
	(*c.*) *Ochry,* .	Contains much clay, sand, and $Ca\ CO_3$	Dull earth of reddish brown colour.		
	(*d.*) *Argillaceous,*	,,	Similar to last, but more compact, and of deeper colour.		

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
	Hematite, *Brown.* *Var.*				
Massive,	(*a.*) *Limnite,* .	$Fe_2H_6O_6 = Fe_2O_3, 3\,H_2O$	S. M. L. Dark-brown, or yellowish, often stalactitic.	5	3·6
Massive,	(*b.*) *Limonite* Bog ore, Ochre,	$(Fe_2O_3)^2, 3\,H_2O$	S. M. L. Dull, dark-brown colour, Often botryoidal and fibrous,	5	3·8
	Yellow clay Ironstone, (*c.*) *Xanthosiderite,*	With earthy impurities.			
4th.	(*d.*) *Göthite,* .	Fe_2O_3, H_2O	A. L. Yellowish or reddish-brown, Often fibrous, massive.	5·25	4·2
Massive,	(*e.*) *Turgite,* .	$(Fe_2O_3)_2, H_2O$	S. M. L. Silky, when compact, very deep red; often botryoidal and fibrous in structure.	6	3·6
5th.	**Crednerite,**	$(Mn_2Cu^3)\,O_3$			
4th.	**Manganite,**	$Mn_2H_2O_4$	S-m. L. Dark steel-gray.	4·0	4·3
Massive,	**Psilomelane,**	$(Ba, Mn)\frac{Mn}{O_2}O$	S-m. L. Iron-black.	5·5	4·01
	Var. (*a.*) Cupreous,	Contains little H_2O, much Cu and H_2O.			
	(*b.*) Cobaltic, *Asbolane,*	Little Ba, much Co and H_2O			
	(*c.*) *Wad* or *Bog Manganese,*	Little Ba, but contains much H_2O.			

Compound Oxides.

2nd.	**Hausmannite,**	$Mn^2\frac{Mn}{O_2}O^2$	S-m. L. Brownish-black.	5·5	4·72
„	**Braunite,** .	$Mn^2\frac{Mn}{O_2}O_2 + Mn\,SiO_3$	S-m. L. Dark brownish-black.		

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
2nd.	Minium, . .	$Pb^2\frac{Pb}{O_2}O^2$	Bright red.	6·5	4·8
Spinelle Group.					
1st. Oct.	Spinelle,	$R\frac{R^2}{O_3}O$		8·0	About 4 average.
	Var. (*a.*) *Balas ruby, Ruby Spinelle, Rubicelle* or *Almandine,*	$Mg\frac{Al^2}{O_3}O$ With traces of Fe	V. L. Purplish; red, yellowish, or blueish, transparent.		
	(*b.*) *Pleonaste,*	Some Mg replaced by Fe	Dark green, or black, Opaque.		
	(*c.*) *Chlorospinelle,*	Some Mg replaced by Cu, and Al by Fe	Bright green, Opaque.		
	(*d.*) *Picotite,* .	Much Mg replaced by Fe, and some Al by Cr	Black.		
"	(*e.*) *Automolite,* (Gahnite),	$Zn''\frac{Al^2}{O_3}O$	V. L. Greenish or brownish-black.	8	4·3
"	Magnetite, *Syn.* Magnetic Iron ore, Magnetic oxide of Iron,	$Fe\frac{Fe^2}{O^3}O$	M. L. Iron black, often massive or granular, and as sand; magnetic.	6·0	·0
"	Franklinite,	$\frac{(FeZnMn)\text{—}(Fe_2Mn_2)}{O_3}O$	M. L. Iron black, massive, magnetic.	6·0	50·6
"	Chromite,	$\frac{(FeMgCr)\text{—}(Cr_2Fe_2Al_2)}{O_3}O$	S-m. L. Brownish-black.	5·5	4·32
"	Pitchblende,	$Ur\frac{Ur_2}{O_3}O$	S-m. L. Pitchy-black or greenish.	5·5	7·2

Crystalline Formula.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
4th.	Chrysoberyl, (Cymophane when opalescent), *Var. Alexandrite,*	$Be_3 \frac{Al_2}{O_3} O_3$	V. L. Greenish, Alexandrite is of a bright green colour, often occurs in radiating groups of crystals,	8·5	3·65
Oxides of Arsenic and Antimony, and Bismuth.					
1st.	Arsenolite,	As_2O_3	V. L White or yellowish incrustations,	1·5	3·69
Oct.	Senarmontite,	Sb_2O_3	R. L. Colourless, transparent,	2·5	5·3
4th.	*Var. Valentinite.*	Sb_2O_3	P. L. White or reddish; often occurs in plates or in long needles,	3	5·56
5th.	Cervantite,	$Sb^3 \frac{Sb^3}{O_5} O_3$	P. L. Yellowish-white, or yellow,	4·5	4·08
?	Bismuth ochre,	Bi_2O_3	Often in yellowish-white crusts.		
Binoxides.					
—	Carbonic Anhydride,	CO_2	Colourless gas, soluble in water, producing carbonic acid, H_2CO_3.		
2nd. Prismatic,	Cassiterite, Syn. Tin stone,	SnO_2	Splendent lustre, brownish-black,	6·5	6·7
	Var. Stream Tin, Wood Tin,	,,	Stream tin occurs as sand. Wood tin in botryoidal masses with fibrous concentric structure,		4·2
2nd. Prismatic.	Rutile,	TiO_2	M. A. L. Deep red or brownish,	6·5	4·2

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
	Var. *Nigrine*, . .	Contains Fe,	Black.		
2nd. Oct.	**Anatase,**	TiO_2	M. A. L. Clove-brown and bluish, or black,	5·5	3·9
4th.	**Brookite,**	TiO_2	M. A. L. Brown or reddish,	6·0	4·2
Oct. often flattened,	*Var. Arkansite,*	Contains Fe.	Black.		
4th.	**Pyrolusite,** when impure, *Varvacite,*	MnO_2	M. L. Deep steel-gray, often occurs in radiating fibrous masses,	2·5	4·81
	Silica, *Var.* (*a.*) *Crystalline, or Sub-crystalline.*	SiO_2		7·0	2·6
Hex.	**Quartz,** Rock crystal, Rose, Amethyst, false Topaz, Milk, Iron, Smoky, Aventurine, Sagenitic, Cat's-eye,	More or less coloured, probably by metallic oxides. *Aventurine* quartz has scattered scales of other minerals imbedded.	V. L. Various.		
,,	**Tridymite,**	SiO_2	Colourless, crystals tabular, occur usually in groups of three,		2·2–2·3
?	(*b.*) *Compact,* Hornstone and Chalcedony (Carnelian, Chrysoprase, Prase, Agate, Onyx, Plasma, Bloodstone), Jaspar, Touchstone, Flint,	SiO_2	Various. Lustre usually waxen.		

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
?	Opal, Precious opal, Fire opal, Common opal, Wood opal, Hyalite, Siliceous Sinter, Float-stone.	Varies between $H_2\frac{Si}{O_3}O$ and $H_2\frac{Si^3}{O_6}O$	Various; usually translucent,	6·0	2·0

SILICATES.

Felspar Group.

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
5th.	Orthoclase, *Syn.* (Common felspar), Orthose, Potash felspar, Loxoclase, .	$K_2' + Al_2\frac{Si^6}{O_{12}}O_4$ When pure, but usually contains some Na',	V. L. White, reddish, greenish, transparent or opaque,	6·0	2·5
	Var. (*a.*) *Sanidine*, *Ice-spar* or Ryacolite,	,,	Flat transparent crystals		
	(*b.*) *Adularia*, or *Moonstone*,	,,	Opalescent, and pearly-white.		
	(*c.*) *Hälleflinta*,	,,	Compact subcrystalline felspars.		
	(*d.*) *Pitchstone*, or *Pearlstone*,		Pitchy or pearly lustre; occurring in spherules called spherulite.		
	(*e.*) *Obsidian*, *Volcanic glass*,	,,	V. L. Occurs in irregular dark-coloured, glassy masses.		
,,	Hyalophane, *Syn.* Baryta-felspar,	$(Ba''K_2') + Al_2\frac{Si^4}{O_8}O_4$	V. L. White or reddish, often transparent,	6·0	2·8
6th.	Albite, *Syn.* Soda-felspar, Tetartine,	$Na'_2 + Al_2\frac{Si^6}{O_{12}}O_4$ Usually contains K'	P. L. Colourless or white, reenish,	6·5	2·62

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
	Var. (*a.*) *Pericline,*		In large stout crystals, white.		
	(*b.*) *Cleavlandite,*		Occurs in white lamellæ.		
	(*c.*) *Petrosilex,*		Like *Hälleflinta.*		
"	Oligoclase, *Syn.* Soda lime felspar, Natron-spodumene,	$(Na'_2Ca'') + Al_2 \frac{Si^4}{O_8} O_4$ or $(Na'_2Ca'') + Al_2 \frac{Si^5}{O_{10}} O_4$	V. L. White and greenish-white, or reddish,	6·5	2·65
"	Andesine (identity doubtful),	Probably variety of Oligoclase containing more Ca and less Si than usual.	V. L. White to red,	5·5	2·68
6th.	Labradorite,	$(Ca''Na'_2K'_2) + Al_2 \frac{Si^3}{O_6} O_4$	V. L. Often pearly. Bluish, greenish, or white, often with beautiful play of colours,	6·0	2·72
"	Anorthite, *Syn.* Amphodelite, Indianite, Christianite,	$Ca'' + Al_2 \frac{Si^2}{O_4} O_4$	V. or P. L. Colourless, or grayish-white, often transparent,	6·5	2·70
3rd. Prisms,	Nepheline, *Var.* (*a.*) *Somnite* when glassy,	$(Na'_2, K'_2, Ca'') + Al_2 \frac{Si^2}{O_4} O_4$ but proportion of Si often greater,	V. or greasy lustre, Usually in small colourless crystals.	6·0	2·6
	(*b.*) *Elæolite* when greasy,	"	Often massive, or in large brownish or greenish crystals.		
	(*c.*) *Cancrinite,* or *Gieseckite.* See Pinite,	Probably nepheline altered; contains H_2O and CO_2			

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
1st. R. Dodecahedron,	Leucite,	$K'_2 + Al_2 \frac{Si^4}{O_8} O_4$	V. L. Usually grayish-white, opaque,	6·0	2·5
" Dodecahedron,	Sodalite,	$Na'_2 + Al_2 \frac{Si^3}{O_4} O_4 + \frac{2}{3} NaCl$,	V. L. Various in colour, from a greenish-white to blue or red; translucent,	5·5	2·2
1st. Oct.	Haüynite,	$Na_2 + Al_2 \frac{Si^3}{O_4} O_4 + \frac{1}{2} CaSO_4$	V. L. Blue or green; translucent,	5·5	2·45
"	Nosean,	$Na_2 + Al_2 \frac{Si^2}{O_4} O_4 + \frac{1}{2} Na_2SO_4$	G. L. Brownish-black to gray,	5·5	2·3
" Dodecahedron,	Lapis Lazuli, *Syn.* Native Ultramarine,	Probably only a mixture of a Na and Ca felspar base with an alkaline or earthy sulphide,	V. L. Beautiful blue, sometimes reddish, sub-translucent,	5·5	2·4

Sub-Group.

5th.	Spodumene, *Syn.* Triphane, For *Killinite.* See Pinite,	$(\frac{1}{3}Li'_6 + \frac{2}{3}Al_2) \frac{Si^3}{O_6} O_3$	V. or P. L. Greenish, nearly opaque,	7·0	3·18
"	Petalite, *Syn.* Castor,	$(\frac{1}{3}Li'_6 + \frac{2}{3}Al_2) \frac{Si^6}{O_{12}} O_3$	P. or V. L. Usually white and massive. Translucent small clear crystals called *Castor*,	6·5	2·45
"	Sphene, *Syn.* Titanite, Greenovite,	$Ca \frac{(\frac{1}{2}Si + \frac{1}{2}Ti)}{O_4} {}_2O$	R. L. Black, brownish, or green; often opaque,	5·5	3·5

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
Mica Group.					
4th, Biaxial,	Muscovite, *Syn.* Potash mica,	$K'_6 + Al_6 \frac{Si^7}{O_{14}} O_{12}$ and some Fe,	P. or V. L. Brownish, dull greenish or colourless; very easily cleaved,	2·5	2·90
	Var. Fuschsite, Chrome mica,	Cr_2 replaces some Al_2	Bright green.		
" Biaxial,	Margarodite (common mica), *Var. Damourite,*	$(K', Na', H)_{10} + Al_8 \frac{Si^9}{O_{18}} O_{17}$ also contains a little Fl.	P. or V. L. Usually silvery-white, easily cleavable,	2·0	2·8
" Biaxial,	Lepidolite, *Syn.* Lithia mica,	$(K'Li')_2 + (Al_2Mn_2) \frac{Si^3}{O_6} O_4$ and Fl.	P. L. Reddish, bluish, or white,	2·5	2·9
" Biaxial,	Phlogopite, *Syn.* Magnesia mica,	$Mg''_6 + Al_2 \frac{Si^5}{O_{10}} O_9$	P. L. A deep-reddish brown, yellow, or greenish,	2·5	2·82
Hex. Usually uniaxial,	Biotite, *Syn.* Magnesia-iron mica,	$(Mg'K'_2)_3 + (Al_2Fe_2 \frac{Si^3}{O_6} O_6$ or $(Mg'K'_2)_3 + (Al_2Fe_2) \frac{Si^4}{O_8} O_6$	Brilliant lustre, usually black or greenish,	2·5	3·0
Hex. ? Usually uniaxial,	Lepidomelane, *Syn.* Iron-mica, common black mica,	$(K_2'Mg'') + (Fe_2Al_2) \frac{Si^2}{O_4} O_4$	V. L. Black or greenish, Laminæ less elastic than those of most other micas,	3	3·0
4th. Biaxial,	Astrophyllite, *Syn.* Titanium mica,	Formula uncertain, Silicate of Al, Fe, Mn, K, and Na, containing Titanium and sometimes Zirconium,	S. M. L. Bronze-like,	3·0	3·28

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
Garnet Group.					
1st. R. Dodecahedron,	**Garnet,** *Syn.* Carbuncle,	$R''_3 + R_2 \frac{Si^3}{O_6} O_6$	V. L. Colours vary from bright red to yellow, greenish, violet-red, or dull brown,	7·0	3·2–4·3
	Var. a. *Grossular,* Essonite, Cinnamon stone,	$Ca''_3 + Al_2 \frac{Si^3}{O_6} O_6$	Pale green, yellow, or dull brown.		
	(*b.*) *Pyrope,* or Bohemian garnet,	$(Mg'',Fe'',Ca'')_3 + Al_2 \frac{Si^3}{O_6} O_6$ Sometimes contains Yttrium.	Rich red.		
	(*c.*) *Almandine,*	$(Fe''Mn'')_3 + Al_2 \frac{Si^3}{O_6} O_6$			
	Precious garnet,		When clear and transparent, red;		
	Common garnet,		When dull, brownish red ;		
	Spessartite,		When rich in Mn.		
	(*d.*) *Colophonite,* Melanite, Topazolite,	$Ca''_3 + Fe_2 \frac{Si^3}{O_6} O_6$	Resinous, brownish or black.		
	(*e.*) *Ouvarovite* Chrome-garnet.	$Ca''_3 + (Cr_2Al_2) \frac{Si^3}{O_6} O_6$	Bright green.		
1st. Tetra.	**Tetrahedral** garnet (Helvin),	$(Be'',Fe'',Mn'')_3 \frac{Si}{O_2} O_2 + \frac{1}{3}MnS$	V. L. Brownish, yellow or greenish,	6·5	3·2
2nd. Prisms.	**Idocrase,** *Syn.* Vesuvian, Egeran,	Probably garnet formula, but usually $Ca''_8 + Al \frac{Si^7}{O_{14}} O_{14}$ Sometimes contains H_2O	V. L. Cinnamon brown or greenish, or bluish; transparent, or translucent,	6·5	3·4

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
"	Sarcolite,	$Ca''_3 + Al_2 \frac{Si^3}{O_6} O_6$	V. L. Reddish; transparent, to translucent,	6·0	2·90
"	Scapolite, *Syn.* Wernerite, *Var. Nuttalite Glaucolite,*	$(Ca''Na'_2)_3 + Al_4 \frac{Si^6}{O_{12}} O_9$	V. L. White or grayish-green; when dull brown, called *Nuttalite;* when massive, greenish or bluish, *Glaucolite.*	5·5	2·7
2nd.	Meionite,	$Ca''_3 + Al_4 \frac{Si^4}{O_8} O_9$ or Si^5	V. L. Colourless or white, sometimes nearly opaque,	6·0	2·73
"	Paranthite,	richer in Al,	V. L. Grayish or greenish,	5·5	2·7
"	Dipyre, *Syn.* Couzeranite, Marialite, Phrenitoid,	$(Ca''Na_2)_3 + Al_4 \frac{Si^9}{O_{18}} O_9$	V. L. Colourless, dull white, greenish; *Marialite* transparent,	6·0	2 6
5th.	Epidote,	$R''_3 + R_4 \frac{Si^4}{O_8} O^9$ or Si^5			
	Var. (*a.*) *Zoisite, Saussurite,*	containing Ca and Al, with Na in addition,	V. L. or P. L. Dull white, greenish or brownish; translucent.	6·5	3·4
	(*b.*) *Arendalite,* Pistacite, or common epidote,	containing CaAl and Fe	V. L. Dark green, sometimes nearly black.		
	(*c.*) *Manganese epidote,* Piedmontite,	containing Ca'Al and Mn	V. L. Dark reddish-brown, sometimes bluish.		
	(*d.*) *Withamite,*	also contains a little Mn	Rich red, or yellowish red; often in minute translucent crystals; pleochroic,		3·2
	(*e.*) *Orthite,* Allanite, or cerium epidote,	containing Ce' Fe' Ca and Al	Black, or brownish black,		3·4

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
4th.	Gadolinite,	$(Y''Ce''Fe)_2\frac{Si}{O_2}O_2$	Glassy, black, or greenish black; subtranslucent,	6·5	4·3
?	Cerite,	nearly the same + H_2O.	R. L. Gray or reddish brown,	5·5	4·9
4th.	Iolite, *Syn.* Dichroite, Cordierite; Hard Fahlunite,	$(Mg''Fe'') + Al_2\frac{Si^3}{O_6}O_4$	V. L. Dull blue in one direction, brownish yellow in another,	7·5	2·6
	Var. Fahlunite (soft), *Bonsdorffite*, *Esmarkite*, *Chlorophyllite*, *Gigantolite and Praseolite*,	All more or less hydrated varieties of Iolite.			
4th.	Lievrite,	A ferroso-ferric silicate of very doubtful formula,	S. M. L. Black, opaque,	6·0	4·0
,,	Chrysolite,	$R''_2\frac{Si}{O_2}O_2$			
	Var. (*a.*) *Forsterite*,	$Mg''_2\frac{Si}{O_2}O_2$	V. L. White, yellowish or green,	6·5	3·3
	(*b.*) *Olivine*,	when ⅛th Mg'' is replaced by Fe''	V. L. Pale olive green, or dull green, in basalts, &c.	6·5	3·4
	(*c.*) *Peridote*, (Fayalite),	$Fe''_2\frac{Si}{O_2}O_2$	R. L. Black, or greenish-black,	6·5	4·0
	(*d.*) *Tephroite*,	$Mn''_2\frac{Si}{O_2}O_2$	V. L. Reddish or gray,	5·5	4·0
Hex.	Willemite, *Syn.* Troostite,	$Zn''_2\frac{Si}{O_2}O_2$	V. L. Greenish yellow, brownish,	5·5	4·0
	Var. 4th Electric Calamine. See hydrous silicates,	When containing one atom H_2O in addition.			

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
Sub-Group.					
2nd.	**Zircon,** *Syn.* Hyacinth Jacinth,	$Zr\frac{Si}{O_2}O_2$	Ad. L. Colourless, greenish; clove brown and reddish,	7·5	4·5
	Var. (*a.*) ***Jargoon,***	Contains Ur.	Smoky, yellowish,		
	(*b.*) ***Malacon,***	Contains water.	Brown,	6·5	4·0
Hex. Rh.	**Eudialyte,** *Syn.* Eucolite,	$(ZrCa''_2Fe''_2)\frac{Si}{O_2}O_2$	V. L. Red, dull red,	5·5	3·0
4th.	**Leucophane,**	$(Be''Ca''Na'_2)\frac{Si}{O_2}O_2$ Contains 6 per cent. of Fe.	V. L. Dull greenish, or yellowish,	4·0	2·97
	Helvin. See Tetrahedral garnet.				
Hex.	**Phenacite,**	$Be''_2\frac{Si}{O_2}O_2$	V. L. Colourless, yellowish or brown,	8·0	2·96
"	**Beryl,** *Syn.* Emerald,	$Be''_3 + Al_2\frac{Si^6}{O_{12}}O_6$	V. L. Emerald-green, blue, or yellowish,	8·0	2·70
5th.	**Euclase,**	$Be''_3 + Al_2\frac{Si^2}{O_4}O_6$ Contains 6 per cent. of H_2O according to Damour.	V. L. Greenish, colourless, or blue,	7·5	3·0
Hornblende Group.					
5th.	**Hornblende,**	$R''\frac{Si}{O_2}O$ or $(R''_3, R_2)\frac{Si^3}{O_6}O_3$		6·0	3·0

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
5th.	*Var.* (*a.*) *Tremolite*, *Syn.* White Hornblende,	$(Mg\,Ca)\frac{Si}{O_2}O$.	S. L. White or gray; often fibrous,		
	Jade or Nephrite,		Compact granular, containing Fe.		
"	(*b.*) *Actinolite*,	$(Mg''\,Ca''\,Fe'')\frac{Si}{O_2}O$	V. L. Various shades of green; usually in long crystals.	5·5	3·0
	Asbestus, mountain leather or cork,	Product of decomposite of fibrous varieties of hornblendic minerals.	S. L. Blue or brown,		
"	*Crocidolite*, (*c.*) *Grünerite*,	$Fe\frac{Si}{O_2}O$	S. L. Brown; often *fibrous*,	5·5	3·7
"	(*d.*) *Hornblende proper*, (Amphibole, or Pargasite),	$(Fe''_3, Mg''_3, Ca'_3, Al_2)\frac{Si^3}{O_6}O_3$	V. L. Dull green, to black,	6 0	3·2
	(*c.*) *Smaragdite*,	Formula same; contains less Fe''; probably only a foliated variety of last.	Pale green.		
4th.	(*f.*) *Anthophyllite*,	Formula same; but contains much Fe'' and little Ca'',	P. L. Brownish, or greenish; often lamellar,	5·5	3·1
5th.	Augite,	$R''\frac{Si}{O_2}O$. or 3 times this.			
	Var. (*a.*) *Diopside*, (Malacolite, white coccolite),	$(Ca''Mg'')\frac{Si}{O_2}O$	V. L. Dull white, or green,	5 5	3·3
	(*b.*) *Sahlite*, (coccolite), 1. Diallage, 2. Asbestus,	$(Ca''Mg''Fe'')\frac{Si}{O_2}O$ Some varieties contain Al,	V. L. Light or dark green; often granular; *Diallage* foliated.	5·5	3·3

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
	(*c.*) *Hedenbergite*,	$(Fe''Ca'')\frac{Si}{O_2}O$	V. L. Black; often lamellated,	6·0	3·54
	(*d.*) *Augite proper*, (Pyroxene),	$(Ca''_3, Mg''_3, Fe''_3, Al_2)\frac{Si^3}{O_6}O_3$	R. L. Greenish or black, usually in short crystals or massive.		
5th.	Ægirine,	$(Fe''_3, Ca''_3, Na'_6, Fe_2)\frac{Si^3}{O_6}O_3$	V. L. Greenish-black,	6·0	3·5
„ ?	Arfvedsonite,	$(Fe''_3, Mn''_3, Na'_6, Fe_2)\frac{Si^3}{O_6}O_3$	V. L. Black,	6·0	3·35
„	Achmite,	Same as last, but contains a little Ti in addition,	V. L. Brownish,	6·0	3·3
6th.	Babingtonite,	$(Fe''_3, Mn''_3, Fe_2)\frac{Si^3}{O_6}O_3$	V. L. Greenish-black,	5·5	3·35
„	Rhodonite,	$Mn\frac{Si}{O_2}O$	V. L. Flesh-coloured,	6·5	3·60
5th.	Wollastonite (Table spar),	$Ca\frac{Si}{O_2}O$	P. L. White, gray, or brownish in tabular crystals,	4·5	2·8
	Var. Edelforsite,	Impure *Wollastonite*,			
4th.	Enstatite,	$Mg\frac{Si}{O_2}O$	V. L. White, or greenish-gray,	5·5	3·2
	Var. Bronzite,	Same, contains a little Fe''.	P. L. And sometimes sub-metallic or bronze-like; green, or brown colour,		
„	Hypersthene,	$(Mg\ Fe)\frac{Si}{O_2}O$	P. L. Brownish black, or deep green; generally foliated,	5·5	3·39
	Var. Diaclasite,	Same with addition of Ca'' and H_2O.	P. L. Greenish yellow, foliated.		

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
***Serpentine Group** (including Clays).*					
4th	**Talc,** (Foliated.)	$(Mg'' H'_2) \frac{Si}{O_2} O$ traces of Fe''	P. L. White, but usually greenish; folia inelastic, greasy feel,	1·0	2·70
	Var. (*a.*) *Steatite,* (massive), Soapstone, Potstone, Lapis Ollaris, French chalk,	Same essentially,		Hardness often reaches 2·0	
	(*b.*) *Cornish Soapstone,* (massive),	Contains 8 % Al. (Probably a mixture),	G. L. White, or greenish,	Less than talc,	2·26
	(*c.*) *Agalmatolite,* (Idol stone),	Varieties containing a little Al.			
	(*d.*) *Meerschaum* (Sea froth, in allusion to its apparent lightness when perfectly dry),	$(Mg''_1 H'_2) \frac{Si}{O_2} O + H_2O$?	G. L. White, yellowish, or reddish-white,	2·0	3·0
,, ? Probably only pseudo, after *chrysolite,*	Serpentine,	$(Mg'' H'_2)_2 \frac{Si}{O_2} O_2 + \frac{1}{2} H_2O$ with a little Fe''	R. L. Various shades of green,	3·0 to 5·0	2·60
	Var. (*a.*) *Precious* and *common* Serpentine,	,,	Precious S. has a rich colour, and is more translucent than common S.		
	(*b.*) Fibrous *Chrysotile* and *Picrolite,*	,,	Fine silky fibres; often imbedded in Serpentine rocks,		
	(*c.*) Foliated-*Marmolite* and *Antigorite,*	,,	Pearly lustre; greenish; foliated.		

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
	(*d.*) *Schiller spar*,	Fe″ replacing much Mg″	Dull green, or brownish with bronze-like lustre occasionally,		
	Chlorite, *Var.*				
Hex. ?	(*a.*) *Chlorite*, original (Peach),	$(Fe''Mg'')_4 + Al_2 \frac{Si^3}{O_4} O^3\ 3H_2O$	P. L. Bluish-green, easily cleaved in thin plates,	1·5	2·8
Hex.	(*b.*) *Pennine* (Kämmererite),	$Mg''_5 + (Fe_2 Al_2) \frac{Si^3}{O_6} O_8 + 4H_2O$ Käm. contains Cr_2	V. L. Various shades of green, sometimes reddish-yellow,	2·5	2·7
5th.	(*c.*) *Ripidolite* (Clinochlore),	$(Mg''Fe'')_5 + Al_2 \frac{Si^3}{O_6} O_8 + 4H_2O$	P. L. Green or reddish; easily cleaved; crystals often group in fan-like masses,	2·5	2·7
?	(*d.*) *Delessite* (massive),	Contains much Fe_2,	Dull green,	2·5	2·89
5th.	**Chloritoid** (Sismundine, Ottrelite),	$(MgFe) + Al_2 \frac{Si}{O_2} O_4 + H_2O$	P. L. Dull greenish; massive foliated,	5·5	3·55
4th.	**Clintonite** (Seyberite, Xanthophyllite),	Ca and Mg and Al silicate similar to the above, but contains much less Si,	S. M. or P. Brownish, or reddish; easily cleaved to thin folia,	4·5	3·0
,,	**Margarite**,	$(Ca''H_2) + Al_2 \frac{Si}{O_2} O_4$	V. L. Dull yellowish white, groups of scaly crystals,	4·0	3·0
Pseudo, after *Iolite* q. v.	**Pinite**,	$(R'_6 Al_2) \frac{Si_2}{O_4} O_3 + H_2O$	Earthy, brownish,	2·5 ?	2·7
,, after *Elæolite*, q. v.	*Var.* (*a.*) *Gieseckite*,	Contains some Fe and Mg,	E. Brownish, or greenish,	3·5	2·8
,, after *Spodumene*, q. v.	(*b.*) *Killinite*,	,,	R. L. Greenish, or yellowish-white,	4·0	2·68

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
Pseudo, after *Scapolite*, q. v.	(c.) ***Wilsonite***,	"	Rose-red,	3·5	2·77
" after *Anorthite*, q. v.	(*d.*) ***Polyargite***,	"	V. L. Occurs in sparkling reddish lamellæ,	4	2·76
4th.	**Pyrophyllite**, Compact varieties, sometimes called ***Agalmatolite***,	$Al_2 \frac{Si^3}{O_6} O_3 + H_2O$	P. L. Like talc; greenish; easily cleaved; greasy,	1·5	2·8
"	**Kaolin** (Porcelain clay, Fuller's earth), *Var.* (*a.*) ***White Lithomarge***, (*b.*) ***Red Lithomarge***.	$Al_2 \frac{Si^2}{O_4} O_3 + 2H_2O$; " ; Much Fe replacing Al,	P. L. White, or variously coloured; under microscope often seen to be made only of minute plates; often six-sided; plastic.	2·0	2·5
Massive,	**Halloysite**,	Similar to last,	Earthy; various shades; not plastic to any extent; translucent, but becomes nearly transparent in water.	1·5	2·12
	Var. (*a*). ***Smectite*** (Fuller's earth),	All ferruginous.	Greenish clay.		
	(*b.*) ***Bole***,	"	Brown or red.		
	(c.) ***Erinite***.	"	Yellowish-red.		
Massive,	**Allophane**,	$Al_2 \frac{Si}{O_2} O_3 + 5\,H_2O$ Sometimes ferruginous,	V. L. Usually blue or green, Occurs in incrustations,	3·0	1·85
Massive,	**Collyrite**,	$Al_4 \frac{Si}{O_2} O_6 + 9\,H_2O$	W. L. White, greasy,	1·5	2·1
Massive,	**Rotten stone**,	Aluminous silicate containing organic matter,	Earthy, dull gray or brownish-black. Gives unpleasant smell when rubbed.		

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
Sub-Group.					
Hex.	Cronstedite,	$(Fe''Mn'')_3 + Fe_2 \frac{Si^3}{O_4} O_6 + 3\,H_2O$	V. L. Black or brownish. Hex. prisms easily cleave to elastic laminæ,	3·5	3·35
Massive,	Hisingerite,	$Fe_2 \frac{Si_2}{O_4} O_3 + 4\,H_2O$	G. L. Black to brownish-black; not cleavable,	3·0	3·04
Massive,	Nontronite, (Chloropal)	$Fe_2 \frac{Si_3}{O_6} O_3 + 4\,H_2O$	Earthy. Opaline. Greenish or yellow; unctuous,	2·5 Varies much.	1·8
Zeolites and allied Hydrous Silicates.					
1st.	Analcime (Cubicite),	$Na'_2 + Al_2 \frac{Si_4}{O_8} O_4 + 2\,H_2O$	V. L. Colourless or white, sometimes a flesh-red tint,	5·5	2·25
	(*a.*) *Cluthalite,*	Contains Fe	V. L. Red crystals.		
	(*b.*) *Picranalcime,*	When altered by substitution of Mg'' for most of the Na',	V. L. Red, or brownish-red.		
2nd.	Edingtonite,	$Ba + Al \frac{Si^3}{O_6} O_4 + 3\,H_2O$	V. L. Dull white; rosy,	4·5	2·70
4th.	Prehnite,	$Ca''_2 + Al_2 \frac{Si^3}{O_4} O_5 + H_2O$	V. L. Various shades of green, usually occurs in globular masses with internal radiating structure,	6·5	2·90
,,	Eudnophite,	Analcime formula,	P. L. Clouded crystals.		
,,	Natrolite, (Needlestone, Soda-mesotype), Fargite when red,	$Na_2 + Al_2 \frac{Si^3}{O_6} O_4 + 2\,H_2O$	V. L. Colourless, or white, long fine crystals occurring in clusters.	5·5	2·20

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
„ ?	**Mesolite,** (Lime and soda mesotype) Antrimolite,	$(Ca''Na_2) + Al_2 \frac{Si^3}{O_6} O_4 + 3 H_2O$	V.L. or S.L. Usually white,	5·0	2·35
	Var. Harringtonite massive,	Contains more Ca	Often occurs in nodules consisting of interlaced crystals,		
„ ?	**Scolezite** (Lime mesotype),	$Ca + Al_2 \frac{Si^3}{O_6} O_4 + 3 H_2O$	S. L. Colourless or white; acicular,	5·5	2·3
„	**Gismondine,**	$Ca'' + Al_2 \frac{Si_2}{O_4} O_4 + 4 H_2O$	V. L. Colourless or white, usually in concretionary forms,	4·5	2·26
4th.	**Thomsonite,** (Faröelite, Mesole, Chalilite, Comptonite, Scoulerite),	$(Ca''Na_2) + Al_2 \frac{Si^2}{O_4} O_4 + 2 H_2O$	V. L. Colourless, usually. Occurs often in masses made up of large radiating crystals,	5·5	2·35
„	**Phillipsite,**	$(Ca K_2) + Al_2 \frac{Si^4}{O_8} O_4 + 5 H_2O$	V. L. White, or reddish crystals, occasionally crossed and always compound,	4·5	2·2
„	**Harmotome** (Cross stone), *Var. Morvenite,*	$Ba'' + Al_2 \frac{Si^5}{O_{10}} O_4 + 5 H_2O$	V. L. White, *Morvenite* colourless. Crystals usually crossed,	4·5	2·45
„	**Stilbite,**	$Ca'' + Al_2 \frac{Si^6}{O_{12}} O_4 + 6 H_2O$	P. L., or V. L. Dull-white, reddish, or full red; occurs in groups of flattened crystals,	4·0	2·16
„	*Var.* (*a.*) *Epistilbite?*	Stated to contain 1 atom less of H_2O.			
„	(*b.*) *Hypostilbite?*	Probably, $(Ca''Na') + Al_2 \frac{Si^4}{O_8} O_4 + 6 H_2O$ or Si^5.			
5th.	**Heulandite,**	$Ca + Al_2 \frac{Si^6}{O_{12}} O_4 + 5 H_2 O$	P. L. White or red; crystals more distinct than those of Stilbite,	4·0	2·20

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
,,	**Brewsterite,**	$(Ba''Sr') + \text{Ⱥl}_2 \frac{Si^6}{O_{12}} O_4 + 5\,H_2O$	P. L. Colourless or yellowish; crystals usually very small,	5	2·44
,,	**Laumontite,** (Efflorescing zeolite),	$Ca + \text{Ⱥl}_2 \frac{Si^4}{O_8} O_4 + 4\,H_2O$	V. L. Reddish or white; loses water, and falls to powder in dry air,	3·5	2·35
Hex.	**Chabasie** (Phacolite),	$Ca + \text{Ⱥl}_2 \frac{Si_4}{O_8} O_4 + 6\,H_2O$	V. L. White or reddish; usually in more or less modified rhombohedra,	4·5	2·1
	Var. Gmelinite,	Contains Na	Apparently hexagonal in form,		
,,	**Levyne,**	$(Ca''Na_2) + \text{Ⱥl}_2 \frac{Si^3}{O_6} O_4 + 4\,H_2O$	V. L. Dull white, greenish, or red tabular crystals,	4·0	2·1
Non-Aluminous.					
2nd.	**Apophyllite** (Ichtyophthalmite),	$(CaK_2) \frac{Si^2}{O_4} O + 2\,H_2O$ Contains Fe about 1 per cent.	V. L. Colourless, greenish, or reddish-white; crystals apparently cubic,	5·0	2·35
4th. ?	**Okenite** (Dysclasite),	$Ca \frac{Si_2}{O_4} O + 2\,H_2O$	Somewhat S. L.; white compact masses of interlaced crystals,	5·0	2·3
	Var. Gurolite,	Contains more Ca and less Si.			
5th.	**Pectolite,**	$(Ca_2Na_2H'_3) \frac{Si}{O_2} O$	V. L. Inclining to silky-white or grayish; compact, fibrous,	5	2·7
Hex.	**Dioptase,**	$Cu \frac{Si}{O_2} O + H_2O$	V. L. Rich emerald green, transparent; crystals distinct,	5·0	3·27
?	**Chrysocolla,**	$Cu \frac{Si}{O_2} O + 2\,H_2O$?	Earthy; green or bluish incrustations,	3·0	2·20

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
4th.	Electric Calamine, *Var. Sullivanite,*	$Zn''_2 \frac{Si}{O_2} O_2 + H_2O$ Contains 14 – 20 per cent. carbonate	V. L. White, yellowish or greenish; often botryoidal,	5·0	3·5
Andalusite Group.					
4th.	Andalusite,	$Al_2 \frac{Si}{O_2} O_3$	V. L. Sometimes pearly, nearly white, gray, or brownish,	7·5	3·2
	Var. (*a.*) *Chiastolite,*	Same with impurity symmetrically arranged within the crystal in form of Greek letter χ.			
5th.	(*b.*) *Sillimanite* (Fibrolite),	Same as Andalusite,	V. C. Brown, long fine crystals; fibrous,	6·5	3·2
6th.	Kyanite, (Disthene), *Var. Rhætizite,*	$Al_2 \frac{Si}{O_2} O_3$	V. L. Blue, of various shades, Rhætizite white,	6·0	3·5
4th.	Staurotide (Cross stone, Grenatite),	$(Fe''_3, Al_2, Fe_2) \frac{Si}{O_2} O_3$	R. L. Dull brown; crystals crossed,	7·5	3·6
2nd.	Gehlenite,	$(Ca''_3, Al_2, Fe''_3) \frac{Si}{O_2} O_3$	R. L. Dull brown, or green crystals, often tabular or short prisms,	6·0	3·00
4th.	Topaz, (Physalite, Pycnite),	$Al_2 \frac{Si}{O_2} O_3$ With $\frac{1}{5}$ O replaced by Fl = 17 per cent. Fl,	V. L. Yellow transparent, reddish, or colourless. Pycnite massive,	8·0	3·5
,,	Chondrodite, (Humite),	$(Mg'' Fe'')_3 \frac{Si}{O_2} O_3$ or often, $(Mg''Fe)_8 \frac{Si^3}{O_6} O_8$ with $\frac{1}{10}$ O replaced by Fl= 7 per cent. Fl.	R. L. Yellow, brownish, or white; crystals usually granular, imbedded, nearly opaque, Humite, the transparent or translucent variety,	6·5	3·2

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
Sub-Group.					
Hex.	Tourmaline, *Var.* (*a.*) *Schorl,*	$(R''_3, Al_2, B_2)\frac{Si}{O_2}O_3$ R = chiefly Fe'' R = .. Fe'' and Mg''.	V. L. Colours various, Common black. Brown.	7·5	3·0
	(*b.*) *Brazilian Emerald,* and Indicolite,	R = .. Fe'' and K'_2	Green, or rich blue.		
	(*c.*) *Rubellite,*	R = Li' with Mn_2; no Fe''	Pink, with a violet shade.		
	(*d.*) *Achroite,*	R = Li and Na'; no Fe	Colourless.		
5th.	Datolite,	$(Ca''_2, B_2, H'_6)\frac{Si}{O_2}O_3$	V. L. White, or dull yellowish, translucent,	5·5	2·90
,,	Axinite,	$(Ca''_3, Al_2, Fe_2, B_2)_2 \frac{Si^3}{O_6}O_6$	V. L. Various shades of smoky brown, often resembling smoke-quartz; crystals axe-like,	7·0	3.27
		TUNGSTATES.			
2nd.	Scheelite,	$Ca''\frac{W}{O_2}O$	V. L. White, yellowish or brown; small pyramidal crystals usually,	5·0	6·0
,,	Stolzite,	$Pb''\frac{W}{O_2}O$	R. L. Greenish, or brown,	3·0	8·0
4th.	Wolfram,	$(Mn''Fe'')\frac{W}{O_2}O$	S. M. L. Brown to black. Usually massive or lamellar,	5·5	7 3

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
		MOLYBDATES.			
2nd.	Wulfenite,	$Pb''\frac{Mo}{O_3}O$	R. L. Bright yellow; crystals often tabular,	3 0	6·5
?	Pateraite,	$Co''\frac{Mo}{O_3}O$?	Black,		
		CHROMATES.			
5th.	Crocoïte,	$Pb\frac{Cr}{O_3}O$	R. L. Bright orange red,	3·0	6·0
"	Vauquelinite,	$(Pb''Cu'')_3\frac{Cr^2}{O_6}O_3$	R. L. Greenish, or dark brown; small flattened crystals,	2·5	5·6
		BORATES.			
6th.	Sassoline (Native boracic acid),	$H_2\frac{B_2}{O_3}O + 2\,H_2O$	R. L. White scaly crystals; acid taste,	1·0	1·40
5th.	Borax (Tincal),	$Na_2\frac{B_4}{O_6}O + 10H_2O$	V. L. Colourless, or dull-white; alkaline taste,	2·0	1·7
1st.	Boracite,	$Mg''_3\frac{B^8}{O_{12}}O_3 + \frac{1}{n}Mg''Cl_2$	V. L. Yellowish-white, or gray,	7·0	2·9
?	Hydroboracite,	$(Mg''Ca'')_3\frac{B^8}{O_{12}}O_3 + 18\,H_2O$	Somewhat silky lustre; white or reddish, foliated or fibrous,	2·0	2 ·0
?	Hydroborocalcite (Hayesine),	Contains Ca'' only.	Appears as an incrustation.		
?	Boronatrocalcite,	Contains Na' in addition to Ca	S. L. White; with taste; concretionary,	1	·65

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
	TITANATES, TANTALATES, AND COLUMBATES.				
Hex.	Menaccanite, *Syn.* Ilmenite, Crichtonite, Axotomous Iron ore,	$Fe\frac{Ti}{O_2}O$ with variable proportions of the isomorphous Fe_2O_3	M. L. Iron-black to steel-gray, slightly magnetic; often massive or granular,	5·5	4·7
	Var. Iserine, Titaniferous Iron sand,	Contains a very small proportion of Ti.	M. L. Iron-black; occurs in grains and minute crystals, supposed to be octohedrons,		
4th.	Polymignite,	Titanate of Zr.	S. M. Black, long slender crystals,	6·5	4·85
"	Æschynite,	Titano-tantalic columbate of Zr, Ce, Fe''.	S. M. Brownish-black, long striated crystals,	5·5	5 0
"	Tantalite,	Tantalate of Fe'' and Mn''. Often contains some Sn.	M. L. Dull black, prismatic crystals.	6·5	7·5
"	Yttro-tantalite,	Contains Y'', Ur'', and Ca'' in addition,	S. M. L. Brownish black; crystals often tabular,	5·5	5·7
"	Columbite,	Columbo-tantalate of Fe'' and Mn''.	S. M. L. Brownish-black; slightly iridescent; easily breaks into angular particles,	6·0	6·0
2nd.	Fergusonite,	Columbate of Y''.	V. L. Brownish-black,	6·0	5·83
1st.	Pyrochlore,	Columbate of Ce'' and Ca''.	V. L. Brownish-yellow; occurs in octohedrons,	5·0	4·1
	ANTIMONIATES.				
2nd.	Monimolite,	$(Pb'', Mn'', Ca'')_4 \frac{Sb_2}{O_5}O_4$	S. M. L. Yellow; often as incrustations,	5·0	5·94

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
2nd.	Bleinerite,	$Pb'_3 \frac{Sb_2}{O_5} O_3 + 4 H_2O$ Cornish specimens contain less Pb.	R. L. White, or grayish, As incrustations,	4·0	4·7

VANADIATES, ARSENIATES. AND PHOSPHATES.

Lead Salts.

Hex.	Vanadinite,	$Pb_3 \frac{V_2}{O_5} O_3 + \frac{1}{3} Pb\,Cl_2$	R. L. Brownish-yellow colour; mamillated forms common,	3·0	6·90
4th.	Descloizite,	$Pb_2 \frac{V_2}{O_5} O_2$	V. L. Brown, or nearly black,	3·5	5·83
Hex.	*Var. Dechenite,*	Contains Fe''	Usually in small bright crystals.		
"	Mimetesite,	$Pb_3 \frac{A^s}{O_5} O_3 + \frac{1}{3} Pb\,Cl_2$	R. L. Bright yellow, or brown; prismatic,	3·5	7·25
"	Pyromorphite,	$Pb_3 \frac{P_2}{O_5} O_3 + \frac{1}{3} Pb\,Cl_2$	R. L. Green, yellow, or brown. Often botryoidal,	4·0	7·0

Calcium Salts.

"	Apatite, (Moroxite, Asparagus stone), *Var.* (*a.*) *Phosphorite,* or (*b.*) *Coprolites,*	$Ca_3 \frac{P_2}{O_5} O_3 + \frac{1}{3} Ca\,(Cl\,Fl)_2$ More or less impure,	R. L. Pale green, yellow, bluish, or white, Prismatic, massive, concretionary.	5·0	3·0
4th.	Haidingerite,	$(Ca''H'')_3 \frac{As_2}{O_5} O_3 + 3H_2O$	V. L. White; nearly transparent. Aggregated minute scaly crystals,	2·0	2·84

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
5th.	Pharmacolite,	$(Ca''H'') \frac{As_2}{O_5} O_3$ $5 H_2O$	V. L. White; usually occurs in groups of long fine crystals,	2·5	2·7
Copper Salts.					
5th.	Clinoclase,	$Cu''_3 \frac{As_2}{O_5} O_3$ $+ 3 Cu''H_2O_2$	P. L. Dull green; blue shades also,	3·0	4·30
,,	Liroconite,	$Cu_3 \frac{(As_2 P_2)}{O_5} O_3$ $+ (Al_2Cu_3) H_6O_6$ $+ 7 H_2O$	V. L. Blue, or greenish blue; crystals generally small,	2·0	2·90
?	Erinite,	$Cu_3 \frac{As_2}{O_5} O_3$ $+ 2 Cu'' H_2, O_2$	R. L. Green, concretionary forms,	4·5	4·00
?	Cornwallite,	Same, with $3 H_2O$ and P in addition,	Green, resembles last,	4·5	4·16
4th.	Olivenite,	$Cu_3 \frac{(As_2P_2)}{O_5} O_3$ $+ Cu''H_2O_2$	V. L. Olive-green, or brownish; sometimes fibrous,	3·0	4·30
,,	Liebethenite,	$Cu_3 \frac{P_2}{O_5} O_3$ $+ Cu''H_2O_2$	R. L. Dull green; often in globular masses,	4·0	3·7
,,	Phosphorochalcite (Pseudomalachite),	Similar,	V. L. Deep green; in minute globules,	4·5	4·2
Hex.	Copper mica (Tamarite),	$Cu_3 \frac{As_2}{O_5} O_3$ $+ 5 CuH_2O_2 + 7 H_2O$	P. L. or Vitreous; emerald green; tabular crystals easily cleaved to thin plates,	2·0	2·5
Hex.	Volborthite,	Hydrous copper vanadiate of uncertain formula,	P. L. Dull green, or greenish yellow. Spheroidal groups of crystals,	3·5	3·50

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
	Iron and Manganese Salts.				
Hex. Rh.	Beudantite,	Phosphato-sulphate of Fe with Pb. In some specimens the P is largely replaced by As,	V. L. Green to brown,	4·0	4·2
5th.	Vivianite,	$Fe''_3 \frac{P_2}{O_5} O_3 + 8 H_2O$	P. or V. L. Various shades of blue, usually dull earthy,	2·0	2·6
4th.	Tryphilline, *Var. Pseudo-triplite,*	$(Fe''Mn,''Li_2)_3 \frac{P_2}{O_5} O_3$	R. L. Dark brown or bluish, generally massive,	5·0	3·50
,, ?	Triplite,	$(Fe'' Mn'')_3 \frac{P_2}{O_5} O_3$ with a variable fluoride. Possibly altered Triphyline,	R. L. Very dark brown,	5·5	3.6
,,	Childrenite,	Fe and Mn phosphate, with H_2O and Al; formula uncertain,	V. L. Dull white, or brownish, Usually occurs as crystalline incrustation,	5·0	3·20
,,	Scorodite, *Var.* Iron sinter; pitchy iron ore,	$Fe_2 \frac{As^2}{O_5} O_3 + 4 H_2O$	V. L. Green to brown,	3·5	3·15
1st.	Pharmacosiderite (Cube ore),	$Fe_2 \frac{As^2}{O_5} O_3 + \frac{1}{2} Fe_2H_6O_6 + 4 H_2O$	S. L. Various shades of green and yellow. In small cubic or tetrahedal crystals.	2·5	3·0
4th,	Dufrenite,	$Fe_2 \frac{P_2}{O_5} O_3 + Fe_2H_6O_6$	S. L. Deep green. Often in radiating tufts,	4·0	3·3
?	Cacoxene,	$Fe_2 \frac{P_2}{O_5} O_3 + Fe_2H_6O_6 + 6 H_2O$	Yellowish concretions,	3·5	3·38

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
Cobalt and Nickel Salts.					
5th.	Cobalt bloom, (Erythrite),	$Co_3 \frac{As_2}{O_5} O_3 + 8\,H_2O$	P. or V. L. Rich rose-red incrustations usually,	2·0	2·9
	Var. Köttigite,	Contains Zn.			
,,	Nickel green,	$Ni_3 \frac{As_2}{O_5} O_3 + 8\,H_2O$	Often pale green incrustation on copper-nickel,	1·0	3·0 ?
Aluminium Salts.					
4th.	Wavellite,	$Al_2 \frac{P_2}{O_5} O_3 + \frac{1}{2} Al_2H_6O_6 + 5\,H_2O$	V. L. Greenish, or yellowish-white, in globular masses with radiating structure,	4·0	2·32
?	Turquois,	$Al_2 \frac{P_2}{O_5} O_3 + Al_2H_6O_6$ Contains a little Cu	S.-R. L. Bright blue, or green; incrusting other minerals,	6·0	2·7
5th.	Lazulite (Blue spar),	$Al_2 \frac{P_2}{O_5} O_3 + (Fe''Mg'')H_2O_2'$	V. L. Rich azure blue, nearly opaque; in prisms or granular masses,	5·5	3·1
?	Plumbo-resinite,	A plumbiferous Al phosphate.			
Phosphates not included in the above Groups.					
2nd.	Uranium-mica (Uranite),	$Ur_4 \frac{P_2}{O_5} O_6 + Cu''H_2O_2 + 7\,H_2O$	P. L. Green, with yellowish shade. Transparent; usually in thin plates; micaceous,	2·5	3·5
4th,	Antunite, (Lime Uranite),	Nearly same, Cu'' replaced by Ca''	P. L. Greenish-yellow, micaceous,	2·5	3·1

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
6th.	Amblygonite,	Uncertain fluo-phosphate of Li and Al.	V. L. Greenish crystals, minute and blunt,	6·0	3·10
5th.	Wagnerite,	$Mg''_3 \frac{P_2}{O_5} O_3 + Mg''Fl_2$	V. L. Yellowish striated prisms,	5·5	3·0
2nd.	Xenotime,	$Y''_3 \frac{P_2}{O_5} O_3$	R. L. Brownish, or yellow; small pyramidal crystals,	4·5	4·5
5th.	Monazite,	A cerium phosphate containing much Th'' and La'',	R. L. Brownish, or reddish; in small flattened crystals.	5 5	5·1
	Var. Cryptolite,	Much of Ce replaced by Di.			
?	Churchite,	Hydrated cerium phosphate, stated to contain some Di.	V. L. Gray to red; fan-like clusters of crystals,	3·0	3·14
4th.	Adamite,	$Zn_3 \frac{As_2}{O_5} O_3 + nZn_2H_2O_2$	V. L. Yellow, or purplish externally,	3·5	4·33
,,	Hopeite,	Supposed to be a cadmiferous Zn phosphate, probably similar to the last mineral, P replacing As,	V. L. Dull white, or reddish brown.	2·5	2·8
,,	Struvite,	$(NH_4)_2Mg_2 \frac{P_2}{O_5} O_3 + 12H_2O,$	V. L. Yellowish, slightly soluble in water; occurs in guano,	2·0	1·7

TELLURATE.

?	Montanite,	$Bi_2 \frac{Te}{O_3} O_3 + 2 H_2O$	Earthy, yellowish incrustations on *Tetradymite,*	Soft.	8·30

Crystalline Form.	Name	Chemical Formula	Lustre, Colour, &c.	Hardness.	Specific Gravity.
		SULPHATES.			
?	Sulphatite,	$H_2 \frac{S}{O_3} O$ or H_2SO_4	Acid liquid occurring in some mineral waters.		
4th.	Thenardite,	$Na_2 \frac{S}{O_3} O$	V. L. White or brownish; saline taste,	2·5	2·70
,,	Glaserite,	$K_2 \frac{S}{O_3} O$	V. L. White; saline taste,	3·5	1·73
,,	Mascagnite, (Volcanic Ammonia),	$(NH_4)_2 \frac{S}{O_3} O + H_2O$	V. L. Yellowish or gray; somewhat bitter taste,	2·0	1·72
,,	Anglesite (Lead vitriol),	$Pb \frac{S}{O_3} O$	A. L. Yellowish-white, or greenish. Often in tabular crystals,	3·0	6·20
	Var. Cupreous, Linarite, in moclinic prisms,	Same with $Cu\ H_2\ O_2$	Blue.		
,,	Celestine,	$Sr \frac{S}{O_3} O$	V. L. White or bluish green shade. Often occurs in aggregations of prisms, and associated with sulphur,	3·5	3·94
4th.	Barite, (Heavy spar), when impure called "Cawk,"	$Ba'' \frac{S}{O_3} O$	V. L. White, gray, yellow, or reddish; usually large flattened crystals.	3·0	4·50
Hex.	Dreelite,	Ca'' replaces ¼ of Ba'' in last.	Occurs in small distinct *rhombohedrons.*		
4th.	Anhydrite, *Var.* (*a.*) *Vulpenite,* (*b.*) *Muriacite,*	$Ca \frac{S}{O_3} O$; Contains a little SiO_2; Contains Na Cl, being a pseudo after rock salt.	V. L. White, more or less dull or reddish; fibrous or lamellar, granular,	3·0	2·90

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
5th.	Gypsum,	$Ca\frac{S}{O_3}O+2H_2O$	P. L. Usually white, crystals flattened,	1·5	2·30
	Var. (*a.*) *Alabaster,*	,,	Massive, subtranslucent.		
	(*b.*) *Rock Satin,*	,,	Fibrous.		
	(*c.*) *Selenite,*	,,	Crystallised and lamellar.		
,,	Glauberite,	$(Ca''Na'_2)\frac{S}{O_3}O$	V. L. Pale, yellow; feeble saline taste,	3·0	2·7
,,	Glauber-salt,	$Na'_2\frac{S}{O_3}O+10H_2O$	V. L. White; saline, somewhat bitter taste,	1·5	1·48
,,	Melanterite (Copperas),	$Fe''\frac{S}{O_3}O+7H_2O$	V. L. Various shades of green; inky taste,	2·0	1·83
,,	Bieberite,	$Co''\frac{S}{O_3}O+7H_2O$	V. L. Rose-red,	2·0	1·9
?	Morenosite,	$Ni''\frac{S}{O_3}O+7H_2O$	V. L. Pale-green,	2·0	2.0
4th.	White vitriol (Goslarite),	$Zn\frac{S}{O_3}O+7H_2O$	V. L. White, or variously tinged; very astringent metallic taste,	2·5	2·0
,,	Epsomite,	$Mg\frac{S}{O_3}O+7H_2O$	V. L. White; taste bitter,	2·0	1 70
,,	Kieserite,	$Mg\frac{S}{O_3}O+H_2O$	R. L. Dull white, usually massive; bitter taste,	2·5	2·50
?	Kainite,	Impure hydrous sulphate of Mg'' and K'	V. L. White or colourless. Often massive; bitter taste,	2·5	2·1 variable.
?	Polyhalite,	Similar to last, but with much Ca''	R. L. Brick-red. Often fibrous; bitter taste,	2·5	2·76

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
"	Langite,	$Cu \frac{S}{O_3} O + 3 Cu H_2O_2 + H_2O$	V. L. Rich blue, with greenish shade. As incrustation sometimes,	3·0	3·5
"	Brochantite,	$Cu \frac{S}{O_3} O + 3 Cu H_2O_2$	V. L. Deep green. Often in small, distinct, easily-cleaved crystals,	4·0	3·8
6th.	Blue vitriol (Chalcanthite),	$Cu \frac{S}{O_3} O + 5 H_2O$	V. L. Pale blue; highly metallic taste,	2·5	2·21
?	Uranochre,	Basic sulphate of Ur containing Cu''	Earthy, yellow incrustation,	—	—
Hex.	Coquimbite,	$Fe_2 \frac{S^3}{O_9} O_3 + 9 H_2O$	S. L. White or yellow, in fine prisms or massive; very astringent, inky taste,	2·5	2·0
?	Copiapite,	Contains ⅛th less S.	P. L. Yellow, scaly,	1·5	2·1
?	Fibro-ferrite.	nearly $Fe_2 \frac{S_2}{O_6} O_3 + 9 H_2O$	Beautiful silky, greenish-yellow fibres,	1·5	1·84
	Other basic Fe Sulphates fall here.				
Hex.	Alum stone (Alunite),	$(Al_2 K'_6) \frac{S}{O_3} O_3 + 1\text{–}2 H_2O$	V. R. Dull white, or reddish. Usually massive,	4·0	2·6
?	Websterite, (Aluminite),	$Al_2 \frac{S}{O_3} O_3 + 9 H_2O$	V. L, White, massive.	1·5	1·60
?	Alumian,	Basic sulphate of Al without H_2O	V. L. White or grayish. Usually massive,	3·0	2·77
5th.	Alunogen,	$Al_2 \frac{S^3}{O_9} O_3 + 18 H_2O$	V. L. White or yellowish; fibrous crusts; crystals tabular,	2·0	1·70

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
1st.	**Alum,**	$R'_2 + Al_2 \frac{S^4}{O_{12}} O_4 + 24 H_2O$	Octohedral or massive,	2·0–2·5	1·7
	Var. (*a.*) *Native alum,*	$R' = K'$.	V. L. Colourless or white; fibrous; agreeable astringent taste.		
	(*b.*) *Mendozite,*	$R' = Na'$.	Nearly same.		
	(*c.*) *Ammonia-alum,*	$R' = NH'_4$.	V. L. White or colourless; fibrous; agreeable astringent taste.		
	(*d.*) *Pickeringite,*	$R = Mg''$.	S. L. Yellowish-white; fibrous or in needles; astringent and bitter taste.		
	(*e.*) *Apjohnite,*	$R = Mn''$.	S. L. White; fibrous.		
	(*f.*) *Halotrichite,*	$R = Fe''$.	S. L. Yellowish; fibrous; astringent inky taste,		

SULPHATO-CARBONATES.

Hex. Rh.	**Susannite,**	$Pb \frac{S}{O_3} O + 3\left(Pb \frac{C}{O_2} O\right)$.	R. L. White, brown, or greenish,	2·5	6·50
4th.	**Leadhillite,**	Same,	R. L. White, brown, or greenish crystals, often flattened prisms with remarkable pearly lustre from chief cleavage planes,	2·5	6·4
"	**Caledonite,**	$Pb \frac{S}{O_3} O + (CuPb) \frac{C}{O_2} O$	R. L. Bluish-green,	3·0	6·4

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
5th.	Lanarkite,	$Pb\frac{S}{O_2}O + Pb\frac{C}{O_2}O$	R. L. Pearly, yellow or greenish-white. In transparent crystalline plates,	2·5	6·4

CARBONATES.

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
Hex.	Calcite, *Var.* (*a.*) Crystals well defined,	$Ca''\frac{C}{O_2}O$ or $CaCO_3$	Lustre varied. Colour, very variable,	3·0	2·70
Rhombohedrons.	*Iceland spar*	. . . .			
Rhombohedrons, with edges bevelled,	*Nail-head spar,*	. . . .			
Rhombohedrons, with curved faces,	*Fontainebleau limestone,*	Crystals include about 50 per cent. of sand,	Brown opaque.		
Scalenohedrons,	*Dog-tooth spar,*	. . . .	Usually colourless or yellowish.		
Rhombohedrons.	*Plumbocalcite,*	Contains less than 5 per cent of Pb.			
	Manganocalcite,	Contains less than 5 per cent of Mn.			
	(*b.*) Obscurely crystalline, *Schiefer spar,*	. . . .	Lamellar.		
	Satin spar,	. . . .	Fibrous.		
	Marble,	. . . .	Saccharoidal.		
	Limestone, chalk,	. . . .	Granular.		
,, Rh.	Dolomite. Magnesian-limestone when massive,	$Ca\frac{C}{O_2}O + Mg\frac{C}{O_2}O$ or $(Mg, Ca), CO_3$.	V. L. White, gray, greenish, reddish-brown, &c. Often granular,		

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
	Var. (*a.*) *Miemite,*	Contains Fe.	Green crystals,	3·5	2·8
	(*b.*) *Gurhofian,*	Contains more Ca'' than Mg.	White and porcelain-like.		
	(*c.*) *Conite,*	Contains more Mg than Ca,	White, opaque.		
Hex. Rh.	Ankerite,	$Ca \frac{C}{O_2} O + (Mg, Fe, Mn) \frac{C}{O_2} O$	V. L. White or reddish-brown; usually massive,	3·5	3·0
,,	Magnesite,	$Mg \frac{C}{O_2} O$	V. L. White or yellowish. Often fibrous, massive,	4·0	3 0
Rh.	*Var. Breunerite,*	Contains a little Fe.			
,, Rh.	Mesitine-spar,	$(Mg' Fe') \frac{C}{O_2} O$	V. L. Yellowish or brown,	4·5	3·30
,, Rh.	Siderite, (Sparry or Spathic Iron, Chalybite),	$Fe \frac{C}{O_2} O$	V. D. White, yellowish or brown. In groups of flattened rhombohedrons,	4·0	3·80
	Clay-Ironstone, massive, argillaceous,	. . . .	Nodular concretions more or less earthy.		
,,	Rhodochroisite (Diallogite),	$Mn'' \frac{C}{O_2} O$	V. L. Rose-red or brown; often massive granular,	4·0	3· 0
,, Rh.	Smithsonite (Calamine),	$Zn \frac{C}{O_2} O$	V. L. White or yellowish-green; often occurring as crystalline incrustation or earthy.	5·0	4·4
4th.	Arragonite,	$Ca \frac{C}{O_2} O$ Usually contains Sr, and sometimes Pb.	V. L. White, yellowish, greenish, or reddish shades; often occurs in radiating masses of crystals; in hexagonal prisms or in stalactitic forms.	3·5	2·93

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
4th.	Strontianite,	$Sr'' \frac{C}{O_2} O$	V. L. Greenish, yellowish. Often in globular masses with columnar structure,	3·5	3·7
"	Cerussite,	$Pb'' \frac{C}{O_2} O$	V. L. or R. L. Colourless or yellowish. Crystals usually flat,	3·5	6·4
"	Witherite,	$Ba'' \frac{C}{O_2} O$	V. L. White, yellowish, or reddish. Often massive and columnar,	3·5	6·3
"	Alstonite, When monoclinic in form *Baryto-calcite.*	$Ba \frac{C}{O_2} O + Ca \frac{C}{O_2} O$ or $(Ba, Ca), CO_3$	V. L. White or gray,	4·5	3·70
"	Lanthanite,	$La \frac{C}{O_2} O + 3 H_2O$	P. L. White or pale pink; small, very thin, tabular crystals.	2·5	2·60
"	Thermonatrite,	$Na_2 \frac{C}{O_2} O + H_2O$	V. L. Yellowish-white incrustations. Alkaline taste.	1·5	1·60
5th.	Trona,	$Na_2 \frac{C}{O_2} O + 4 H_2O$	V. L. Yellowish-white. Fibrous; alkaline taste,	2·5	2·1
"	Natron,	$Na_2 \frac{C}{O_2} O + 10 H_2O$ More or less impure,	Like last,	1·5	1·5
"	Gay-Lussite,	$Na_2 \frac{C}{O_2} O$ $+ Ca \frac{C}{O_2} O + 5 H_2O$	W. L. Yellowish-white, elongated spike-like crystals,	2·5	1·90

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
5th.	Hydromagnesite,	$3\left(Mg\frac{C}{O_2}O\right) + Mg\,H_2O_2 + 3\,H_2O$	V. L. White, earthy,	3·5	2·15
?	Hydrodolomite, *Var. Pennite,*	Dolomite + aq. Contains Ni.	Earthy, yellowish-white incrustations,	2·5	2·49
?	Emerald Nickel,	Hydrous basic Carbonate of Ni.	V. L. Green crystalline crusts,	3·0	2·6
?	Bismutite (Bismuth ochre),	Hydrous basic Carbonate of Bi.	V. L. White, greenish or yellow. Often as incrustation.	4·5	7·67
?	Hydrozincite (Calamine),	Hydrous basic Carbonate of Zn.	V. L. White of yellowish earthy,	2·5	3·7
?	Aurichalcite (Brass ore),	Similar to last. Cu replacing much Zn.	P. L. Yellowish green incrustations,	2·0	3·32
5th.	Chessylite (Azurite),	$2\left(Cu\frac{C}{O_2}O\right) + Cu\,H_2O_2,$	V. L. Azure-blue crystals or earthy masses,	4·0	3·70
"	Malachite, *Var. Lime Malachite,*	$Cu\frac{C}{O_2}O + Cu\,H_2O_2$	Ad. L. Green of various shades, usually massive, contorted,	4·0	3·90
Sub-Group.					
2nd.	Phosgenite (Corneous Lead),	$Pb\frac{C}{O_2}O + Pb\,Cl_2$	Ad. L. White or yellowish prismatic crystals,	3·0	6·10
Hex.	Parisite,	Fluo-carbonate of Ce, Di and La.	V. L. Dull-yellow,	4·5	4·35

Crystalline Form.	Name.	Chemical Formula.	Lustre, Colour, &c.	Hardness.	Specific Gravity.
		NITRATES.			
?	Nitrocalcite,	$Ca\frac{N_2}{O_6}O + H_2O$	White silky efflorescences; bitter taste.		
?	Nitro-magnesite?	Mg replacing Ca.			
Hex.	Nitratine (Chili nitre),	$Na_2\frac{N_2}{O_5}O$ or $NaNO_3$ more or less impure,	V. L. White or brownish; cooling taste,	1·5	2·20
4th.	Nitre,	$K_2\frac{N_2}{O_5}O$ or KNO_3	V. L. White or brownish; taste cooling,	2·0	1·93
		OXALATES AND MELLITATE.			
5th.	Whewellite,	Oxalate of Ca.	V. L. Brownish-white,	2·5	1·83
?	Humboldtite,	Hydrated Ferrous Oxalate,	R. L. Yellow. Occurs in plates or in fibrous concretions,	2·0	2·3
2nd.	Mellite (Honey stone),	$Al_2\frac{C^{12}}{O_{12}}O_3 + 18H_2O.$	R. or V. L. Honey-yellow or reddish, usually transparent.	2·5	1.60

NOTE.—In all the foregoing formulæ the oxygen may obviously be united, and the simple atomic ratios expressed in the usual manner, as shown in the case of Calcite and in that of Nitre.

XV.—*On the Extension of the Coal-Fields of England under the Newer Formations, being the Abstract of a Lecture delivered on the* 16*th April*, 1871, by Professor EDWARD HULL, M. A., F. R. S., F. G. S.

THE lecturer commenced by tracing out the limits of the area in Britain over which the Coal-measures had originally been deposited. It was shown that throughout the Coal period there existed in England a ridge of the older rocks, stretching across the country from Shropshire and Herefordshire in the West, to the Eastern Counties. This ridge separated the Coal-measures into two large areas;—one to the south of the ridge (or barrier) covering the greater part of the South of England and Wales, and connected with the Coal-formation of France and Belgium; the other to the north of the ridge (or barrier) covering the whole of the North of England and Wales, with the exception of the higher eminences of North Wales, the Lake District, and (probably) the South of Scotland.

It was then shown that, at the close of the Carboniferous period, the strata were thrown into a series of folds, with axes ranging east and west, as well in the South of England as in the North. These disturbances of the strata were accompanied by enormous denudation of materials in certain districts of Lancashire and Yorkshire in the North, and Somerset in the South.

At the close of the Permian period the Carboniferous and Permian formations were thrown into a series of folds along axes ranging north and south; in other words, at right-angles to those of the preceding period. These disturbances were also accompanied and followed by great denudation of the strata over the upraised portions, so that the Coal-formation, owing to the intersection of these two systems of axes, and the concomitant denudation, has been shaped into a series of "basins," of greater or less extent, over the whole British area.

Over the Carboniferous and Permian formations thus arranged e Trassic strata were deposited, attaining their maximum developm towards the North-West of England, and thinning away towards the South-East.

The Lecturer concluded by pointing out the probable limits of the Coal-measures in the Eastern and Southern Counties, and by expressing an opinion that the Coal-resources of Britain were very far from verging upon exhaustion.

XVI.—*Return of Donations to the Royal Dublin Society.*

THE LIBRARY.

COLONEL W. R. HALIDAY, COMMANDANT AND INSPECTOR-GENERAL, HYTHE.

Ahn (F., . . . Professor at the College of Neuss), A New Practical Grammar of the Dutch Language . . , 8vo. *London:* 1854

Alison (Archibald, F. R. S. E., Advocate), History of Europe from . . . the French Revolution in 1789, to the Restoration of the Bourbons in 1815. In Four Volumes. 8vo. *New York:* 1842–43

Alken (Henry), The National Sports of Great Britain, with Descriptions in English and French. Folio. *London:* 1821

Amanda und Eduard, ein Roman in Briefen. Herausgegeben von Sophie *Mereau*. In zwei theile. 8vo. *Frankfort a M.* 1803

ΑΝΑΚΡΕΟΝΤΟΣ ΚΑΙ ΣΑΠΦΟΥΣ ΜΕΛΗ. *Anacreontis* et *Sapphonis* Opera . . . 8vo. *Glasguae,* 1744

Andersen (H. C.). Kun und Spillemand. Original Roman. i tre Dele. *Kjöbenhavn*, 1837

H. WILD . . . DIRECTEUR DE L'OBSERVATOIRE PHYSIQUE CENTRAL DE RUSSIE.

Annales de l'Observatoire Physique Central de Russie, publiée par H. *Wild* . . . directeur de l'Observatoire . . . Année 1866. Folio. *St. Petersbourg* 1870

THE PROVOST AND SENIOR FELLOWS OF TRINITY COLLEGE.

Astronomical Observations made at Dunsink, the Observatory of Trinity College, Dublin . . . First Part. 8vo. *Dublin:* 1870

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Bennet (J. Henry, M. D., . . .), Winter in the South of Europe: or, Mentone, The Riviera, Corsica, Sicily, and Biarritz, as Winter Climates. Third Edition. 8vo. *London:* 1865

ED. PERCEVAL WRIGHT, M. D., PROFESSOR OF BOTANY, T. C. D.

Bérenger (A. di), Dell'antica Storia et Giurisprudenza Forestale in Italia. Con Tavole. 4to. *Trevizo e Venezia* 1859–1865

Bernard (M. Claude, . . .), Leçons de Physiologie Éxperimentale appliquée a la Medicine, faites au Collége de France, . . .
Tome 1er . . . *a Paris,* 1855
Tome Deuxieme . . . ,, 1856

Bernard (M. Claude, . . .), Leçons sur les effets des Substances Toxiques et Médicamenteuses, . . . [*Cours de Médecine du Collége de France*] 8vo. *Paris,* 1857

Ed. Percival Wright, M. D., Professor of Botany, T. C. D.

Bernard (M. Claude, . . .), Leçons sur la Physiologie et la Pathologie du Système Nerveux . . . [*Cours de Médecine du Collége de France*] Tome I.—Tome II. 8vo. *Paris*, 1858

Bernard (M. Claude, . . .), Leçons sur les Propriétés Physiologiques des Liquides de l'Organisme . . . [*Cours de Médecine du College de France*] Tome Premier, Tome Seconde. 8vo. *Paris*, 1859

Colonel W. R. Haliday, Inspector-General, Hythe.

Biblia Herbraica Sine punctis . . . , notisque Masoretarum quas Kri and Krif appellant, instructa. Ad *Leusdenianam* Editionem adornata. 12mo. *Amstelaedami*, 1701

Dr. W. Thornhill.

Bigandet (the Rt. Rev. P., Bishop of Ramatha, Vicar Ap. of Ava and Pegu), The Life, or Legend of *Gaudama*, the Budha of the Burmese . . . and Notice of the Phongyies or Burmese Monks. 8vo. *Rangoon;* 1866

Colonel W. R. Haliday, Inspector-General, Hythe.

Bremer (Frederike), Die Nachbarn. Aus dem Schwedischen . . .
Ertser Theil,
Zweiter Theil. Dritte . . . Auflage.
8vo. *Leipzig:* 1842

The British Association for the Advancement of Science.

British Association for the Advancement of Science; Report of the Fortieth Meeting, held at Liverpool in September, 1870. 8vo. *London:* 1871

Colonel W. R. Haliday, Inspector-General, Hythe.

Cæsaris (C. Julii) Commentarii.
Cum Supplementis *A. Hirsii* et aliorum,
Recognovit Franciscus *Oehler.* 8vo. *Lipsiæ.* 1859

Cantici Sacri ad uso dei Cristiani d' Italia. 8vo. *s. l.* 1853

Carina (Alessandro . . .), Dei Bagni di Lucca. Notizie Topografische, Storice e Mediche. 8vo. *Firenze*, 1866

Carlén (Emilie), Rosen på Tistelön . . . 8vo. *Stockholm*, 1842

Carr (Rev. John, M. A., . . .), A Synopsis of Practical Philosophy, alphabetically arranged. 18mo. *London:* 1843

The Orator.

Carroll (William G., A. M., Incumbent), Sermons preached in St. Bride's Church, Dublin. 8vo. *Dublin:* 1871

E. Percival Wright, M. D., M. R. D. S., &c.

Catalogo Poliglotto delle Piante, compilato della Contessa di *San Giorgio*. 8vo. *Firenze*, 1870

THE SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION.

**Catalogue* of the First . . . Exhibition of National Portraits, ending with the Reign of King James the Second, on loan to the South Kensington Museum. April, 1866. 4to. *London: s. a.*

**Catalogue* of the Second . . . Exhibition of National Portraits, commencing with the Reign of William and Mary and ending with the year MDCCC., on loan to the South Kensington Museum. May 1, 1867. 4to. *London: s. a.*

**Catalogue* of the Third and concluding Exhibition of National Portraits, commencing with the Fortieth year of the Reign of George the Third and ending with the year MDCCCLXVII., on loan to the South Kensington Museum. April 13, 1868. 4to. *London: s. a.*

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Channing (William E., D. D.), The Works of. Third Edition. 5 Vols. 8vo. *Glasgow,* 1840

THE EDITOR.

Collapse of the Faith (the): or, the Unity of Christ as now taught by the Orthodox. Edited by Rev. W. G. *Carroll,* A. M., St. Bride's, Dublin. 12mo. *Ramsgate, and Dublin, s. a.* [1871]

THE AUTHOR.

Colomb (Capt. I. C. R., Adjutant Limerick Artillery). The Reorganization of our Military Forces. Forming Part II. of "Imperial Defence." 8vo. *London: Portsmouth:* 1871

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Comte (M. Auguste, . . .), Cours de Philosophie Positive, tome Troisieme, contenant la Philosophie Chimique et la Philosophie Biologique. 8vo. *Paris,* 1838

Conscience (Hendrik), Baes Gansendonck. Met vier Platen door Ed. *Dujardin.* Tweede Uitgaef. 8vo. *Antwerpen,* 1851

Conscience (Hendrik), Blind Rosa. Met vier Platen door Ed. *Dujardin.* Tweede Uitgaef. 8vo. *Antwerpen,* 1853

Conscience (Hendrik), De Loteling Met vier Platen door Ed. *Dujardin.* Tweed Uitgaef. 8vo. *Antwerpen,* 1851

Conscience (Hendrik), Houten Clara. Met vier Platen door, Ed. *Dujardin.* Tweede Uitgaef. 8vo. *Antwerpen,* 1853

Cornelii Nepotis Liber de Excellentibus Ducibus . . . cum Vitis *Catonis* et *Attici.* Recognovit Rudolphus *Dietsch.* 8vo. *Lipsiae* 1840

EDWARD PERCEVAL WRIGHT, M. D., PROFESSOR OF BOTANY, T. C. D.

Darcy (James George, M. D., M. R. C. S., Lond., . . ,), The Ganglionic Nervous System; its Structure, Functions, and Diseases. 8vo. *London:* 1858

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Degerando (M., Membre de l'Institut de France), Le Visiteur du. Pauvre . . . Troisieme edition. 8vo. *à Paris*, 1826

De Morgan (Augustus, F. R. A. S., and C. P. S., . . .), The Differential and Integral Calculus . . . [LIBRARY OF USEFUL KNOWLEDGE] 8vo. *London:* s. a., [1842]

Dieterich (C. W., Ph. Dr.), Kurze Anweisung zur Leichten Erlernung Der Swedischen Sprache, ... 8vo. *Stockholm und Leipzig*, 1844

Forcellini (Egidii), Totius Latinitatis Lexicon, consilio et Cura Jacobi *Facciolati* . . . , lucubratum editio altera Completior. . . . 4 voll. folio. *Patavii*, 1805
Appendix. *Patavii*, 1816

Gesenius (William, . . .), A Hebrew and English Lexicon of the Old Testament, including Biblical Chaldee. Translated from the Latin . . . by Edward *Robinson*, D. D., . . . a new Edition . . . 8vo. *London:* 1844

Graglia (C.), . . . Pocket Dictionary of the Italian and English Languages . . . and . . . Elementary Italian Grammar [Fifteenth Edition]. 12mo. *London: s. a.* [1829]

Greene (the Rev. Henry . . .), Man: a Story of Light and Darkness . . . 8vo. *London:* 1866

Heinsius (D. Theodor, . . .), Theoretische—praktische Deutsche Sprachlehre . . . Vierzehnte, durchweg verberserte Auflage. 8vo. *Berlin*, 1846

THE AUTHOR.

Hibernicus, How is Ireland to be Regenerated? or, State Education, *versus* Ecclesiastical. 8vo. *Omagh:* 1870

THE REV. W. G. CARROLL, A. M., ST. BRIDE'S, DUBLIN.

Hinds (Samuel, D. D. (late Lord Bishop of Norwich,),), a Reply to the question, "Shall I seek Ordination in the Church of England?" 12mo. *Ramsgate.* 1871

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

'ΟΜΗΡΟΥ ΙΛΙΑΣ. *Homeri Ilias.* 2 voll. *Glasguæ* 1747

Horatii Flacci (Q.), quae supersunt, recensuit et notulis instruxit. Gilbertus *Wakefield*, A. B., . . .
Volumen Prius, Carmina complectens.
Volumen Posterius, Satiras et Epistolas complectens.
12mo. *Londini:* 1794

Horatii Flacci (Q.). Opera Omnia—ex recensione John Christiani *Jahn.* Editio sexta emendatior. Curavit Theodor *Schmid* . . . 8vo. *Lipsiae* 1861

THE AUTHOR.

Hutton (Henry Dix), Religion of Humanity: . . . Europe's Need and England's Duty. . . . 8vo. *London:* 1870

THE INDUSTRIAL MUSEUM, MELBOURNE.

Industrial Progress of New South Wales: being a Report of the Intercolonial Exhibition of 1870, at Sidney; . . . 8vo. *Sydney:* 1871

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Jelf (William Edward, B. D., . . .). A Grammar of the Greek Language, chiefly from the German of Raphael *Kühner*. Second Edition.

Vol. I.—Accidence.
Vol. II.—Syntax. 8vo. *Oxford:* 1851

THE AUTHOR.

Jencken (Ferdinand E., M. D., M. R. C. P.). Vaccination impartially reviewed . . . 8vo. *London:* 1868

THE AUTHOR.

Jencken (Ferdinand E., M. D., M. R. C. P., Lond.). The Cholera: its Origin, Idiosyncrasy, and Treatment. 8vo. *London:* 1867

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Jung (Johann Heinrich, genannt *Stilling*), Lebensgeschicte, . . . Neue Vollstandige Ausgabe . . . 16mo. *Stuttgart:* 1843

ΚΑΙΝΗ ΔΙΑΘΗΚΗ. *Novum Testamentum*, in quo Tum selecti versiculi 1900, quibus omnes Novi Testamenti voces continentur, asteriscis notantur; Tum omnes & singulæ voces, semel vel sæpius occurrentes, peculiari nota distinguuntur, auctore Johanne *Leusden*, Professore. 8vo. *Amstelaedami*, 1698

THE AUTHOR.

Kirby (W. F.), Ed-Dimiryaht. An Oriental Romance: and other Poems . . . 8vo. *London:* 1867

COLONEL W. A. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Kitto (John, . . .), Palestine: The Bible History of the Holy Land. . . . 4to. *London:* 1841

Kitto (John, . . .), Palestine: The Physical Geography and Natural History of the Holy Land . . . 4to. *London:* 1841

Labbe (Philippi, Biturici, Soc. Jesu Sacerdotis) . . . Eruditæ Pronuntiationis Catholici Indices . . . Ab Edwardo *Leedes* olim recogniti et aucti; . . , 8vo. *Londini:* 1796

Legendre (A. M., . . .), Essai sur la Théorie des Nombres; seconde édition. 4to. *Paris*, 1805

Supplément, ,, 1816
Second Supplément, ,, 1825

Leopold (Dr. E. F.), Lexcion Græco-Latinum Manuale . . . Altera Editio . . . 16mo. *Lipsiæ* 1852

Lessing's (Gotth. Ephraim) Gedichte.
Erster Theil.
Zweiter Theil.
Neuste Auflage. 16mo. *Wien* 1816

COLONEL W. A. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Lucretii Cari (Titi) de Rerum Natura libri sex. Ex editione Thomæ *Creech.* 8vo. *Glasguæ,* 1749

THE AUTHOR.

Maguire (Joseph, Archt., M. R. D. S., . . .), Healthy Dwellings for Labourers, Artizans, and the Middle Classes, . . . Paper read at . . . The Royal Dublin Society, on the 18th March, 1867. 8vo. *Dublin:* 1867

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Manual of Mathematical Tables, by the Rev. Joseph A. *Galbraith,* M. A.. . . .; and the Rev. Samuel *Haughton,* M. A., F. R. S., . . . 8vo. *London:* 1860

THE AUTHOR.

Mapother (E. D., M. D., . . .), Animal Physiology. [*Gleig's School Series.*] 24to. *London* 1871

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Mascheroni (L.), Géométrie du Compas; ouvrage traduit de l'Italien par A. M. *Carette,* Officier du Genie. 8vo. *a Paris, An.* VI. (1798)

Mathematics. Vol. I. . . . [Library of Useful Knowledge.] 8vo. *London:* 1847

THE INDUSTRIAL MUSEUM, MELBOURNE.

Melbourne, Industrial and Technological Museum.—Lectures delivered in . . . , the Museum during the Spring Session of 1870. . . 8vo. *Melbourne:* 1871

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Milner (the late Rev. Joseph, A. M.), The History of the Church of Christ . . . with Additions and Corrections by the Rev. Isaac *Milner,* D. D., F. R. S., Dean of Carlisle, and President of Queen's College, Cambridge. A new edition. 5 voll. 8vo. *London:* 1819

Monge (G.), Geometrie Descriptive; cinquième édition; augmentée d'une Théorie des Ombres et de la Perspective, extraite des papiers de l'auteur, par M. *Brisson,* . . . 4to. *Paris,* 1827

Nochden (George Henry, Ph. D., LL.D. . . . A Grammar of the German Language. Fifth edition. 12mo. *London:* 1826

Nunn (Richard, Esq., Assistant Barrister for the County of Tyrone), and John Edward *Walsh,* Esq., Barrister-at-Law, The Powers and Duties of Justices of the Peace in Ireland, and of Constables . . . Second edition . . . In two volumes. 8vo. *Dublin:* 1844

THE AUTHOR.

O'Dwyer (Michael John, Esq.), The Soldiers' Marriages. A Musical Drama . . . 8vo. *Dublin:* 1861

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Ovidius Naso (P.). Ex recognitione Rudolphi *Merkelii.* Tom. II. Metamorphoses. 8vo. *Lipsiae.* 1865

Pascal (Blaise), Pensées de. 32mo. *Paris,* 1823

Pascal (B.), Les Provinciales, ou Lettres de Louis de Montalte. Deux Tomes. 18mo. *Paris,* 1815

Penn (Granville, Esq.), A Comparative Estimate of the Mineral and Mosaical Geologies. 8vo. *London:* 1822
Supplement. . . 8vo. *London:* 1823

Petersdorff (Charles, Serjeant-at-Law); assisted by Charles W. *Wood*, Esq., and Walker *Marshall*, Esq., Barrister-at-Law, a concise, Practical Abridgment of the Common and Statute Law. . Second edition, . . Vol. I. 8vo. *London:* 1861

Pim (Jonathan), The Condition and Prospects of Ireland. . . 8vo. *Dublin,* 1848

Pisani (Madame [Marian] . .), The Convent and the Harem. In three volumes. 8vo. *London:* 1851

Plinii Caecili Secundi (C.), Epistularum libri novem . . recognovit Henricus *Keil.* 8vo. *Lipsiae* 1853

Poor Law Unions and Electoral Divisions in *Ireland*, . . List of the Marriage Registrar's Districts, . . compiled . . by Arthur *Moore*, Esq., . . 8vo. *Dublin:* 1847

FROM THE AUTHOR.

Protestant Celt (A), Irish Nationality in 1870. Second edition, with a commentary on the "Home Rule Movement" . . 8vo. *Dublin:* 1870

GEORGE JOHNSTONE STONEY, ESQ., SECRETARY, QUEEN'S UNIVERSITY.

Queen's University Calendar, 1867.	8vo.	*Dublin:*	1867
,, ,, ,, 1868.	8vo.	,,	1868
,, ,, ,, 1869.	8vo.	,,	1868
,, ,, ,, 1870.	8vo.	,,	1869
,, ,, ,, 1871.	8vo.	,,	1870

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Quintiliani (M. Fabii) De Institutione Oratorii libri XII. . . Editio stereotype. Tomi I-II. *Lipsiae* 1829

Recueil des Pièces de Théatre. . . lues par M. *Le Texier* en sa Maison, Lisle-street, Leicester-Fields, 8vo.

Tome I.,	*a Londres:*	1799
Tomes II., III., IV.,	,,	1785
,, V., VI.,	,,	1786
Tome VII.,	,,	1787

Reiff (Charles Philip). English Russian Grammar, . . . for the use of Englishmen . . . Second Edition, completely remodelled. 8vo. *Carlsruhe.* 1853

M. RIKATCHEFF, LE DIRECTEUR DE L'OBSERVATOIRE CENTRAL PHYSIQUE DE RUSSIE.

Repertorium für Meteorologie, herausgegeben von der Kaiserlichen Akademie der Wissenschaften, redigert von Dr. Heinrich *Wild*, . . . Band I. 4to *Sanktpeterbyrge* ——

EDWARD CLIBBORN, R. I. A.

Report (First Annual), of the Geological Survey of Indiana, made during . . . 1869, by E. T. *Cox*, State Geologist, assisted by Prof. Frank H. *Bradley*, Dr. Rufus *Raymond*, and Dr. G. M. *Levette*. [*with case of Four Maps*] 8vo. *Indianopolis:* 1869

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Reumont (Alfred von) Geschihte der Stadt Rom. Erster Band. 8vo. *Berlin*, 1867

THE AUTHOR.

Reynolds (J. Emerson, . . ., Analyst to the Royal Dublin Society), Research on a New Group of Colloid Bodies, containing Mercury, and . . . Fatty Ketones. [From the Proceedings of the Royal Society, No. 128, 1871]. *s. l. s. a.*

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Riddle (Rev. J. E., M. A., . . .), A Diamond Latin-English Dictionary: . . . New Edition. 16mo. *London:* 1859

Riddle (the Rev. Joseph Esmond, M. A., . . .) and the Rev. Thomas Kerchever *Arnold*, M. A., . . ., A copious and Critical English-Latin Lexicon, founded on the German-Latin Dictionary of Dr. Charles Ernest *Georges*. 8vo. *London:* 1847

Schiller (Friedrick's von) Sämmtliche Werke.
Vollständige ausgabe in einer Bande.
Erster Theil.
Zweiter Theil.
Dritter Theil. 8vo. *Haag*, 1830

Schleusner (Joh. Friedar.) Lexicon Græco-Latinum in Novum Testamentum. In compendium redegit Joannes *Cary*, LL. D.
Pars Prima. [A—K.],
Pars Secunda. [Λ—Ω.] 8vo. *London* 1826

MR. HUGH JAMES FENNELL.

Shepherd (the late Rev. Samuel, Rector . . . of the . . . Parishes of Celbridge and Straffan . . . of Timahoe, Ballymackwilliam and Donadea; . . .), The Poetical Works of. 8vo. *Dublin:* 1790

THE CHIEF SECRETARY'S OFFICE, ADELAIDE, SOUTH AUSTRALIA.

South Australia. Blue Book for the year 1869. Folio. *Adelaide:* 1870

Statistical Register of South Australia for 1869. . . Folio. *Adelaide:* 1870

THE REGISTRAR-GENERAL'S OFFICE, WELLINGTON, NEW ZEALAND.

Statistics of New Zealand for 1869. Compiled from Official Records. Folio. *Wellington:* 1870

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Sternhagen's: Der kleine Däne, fur Lehrer und Lernende, . . . Tweite auflage, vielfach vermehrt und verbessert von dem Dänen *Le Petit*, Dr. 12mo. *Hamburg*, 1844

Tate (William), The Counting-House Guide to the Higher Branches of Calculations. Part the First. Part the Second. 12mo. *London:* 1844

Terentii Afri (Publii) Comœdiae Sex, ex editione *Westerhovania* Recensita. . . 8vo. *Glasguæ:* 1742

Theater von Gotth Ephraim *Lessing*. Neuste auflage. 6 voll. 16mo. *Wien* 1817

Tholuck (Dr. A., . .), Commentator zum Evangelio Johannis, . . Fünfte umgearbeitete auflage. 8vo. *Hamburg*, 1837

Tholuck (Dr. A., . .), Das Alte Testament im Neuen Testament . . Neue Ausarbeitung. Dritte auflage. 8vo. *Hamburg*, 1849

DR. F. E. JENCKEN.

Tomkins (Frederick J., Esq., M. A., D. C. L., . .), and Henry D. *Jencken*, Esq., Barrister-at-Law. . . A Compendium of the Modern Roman Law, founded on the Treatises of *Puchta*, *Von Vangerou*, *Arndts*, Franz *Moehler*, and the *Corpus Juris Civilis*. 8vo. *London:* 1870

THE COLONIAL MUSEUM, WELLINGTON, NEW ZEALAND.

Transactions and Proceedings of the New Zealand Institute, 1870 Vol. III. Edited and Published . . . by James *Hector*, M. D., F. R. S. 8vo. *Wellington*, [1871]

THE AUTHOR.

Traquair (Ramsay H., M. D., F. R. G. S. I., . . .), On Griffithides Mucronatus. [Read before the Royal Geological Society of Ireland, in December, 1869.] 8vo. *s. l., s. a.*

Traquair (Ramsay H., M. D., F. R. G. S. I., . . .), Notes on Calamoichthys Calabaricus (J. A. Smith). [Read before the Royal Geological Society of Ireland, June 8, 1870.] 8vo. *s. l., s. a.*

Traquair (Ramsay H., M. D., Edin., . . .), On the Cranial Osteology of Polypterus. [Read before Section D. of the British Association, at Liverpool, September 20, 1870.]

[From the Journal of Anatomy and Physiology. Vol. V., pp. 166- to 183.]

COLONEL W. R. HALIDAY, INSPECTOR-GENERAL, HYTHE.

Walker (J., . . .), A Rhyming Dictionary; . . . the English Language . . . arranged according to its TERMINATIONS. . . . A New Edition. 12mo. *London:* 1836

Wilberforce (William), The Life of. By his Sons, Robert Isaac *Wilberforce*, M. A., Vicar of East Farleigh, . . . and Samuel *Wilberforce*, M. A., Rector of Brighstoue. In Five Volumes. 8vo. *London:* 1838

Zschokke (Heinrich), Des Schweizerlands Geschichte für das Schweizervolk. 8vo. *Aarau* 1834

Zschokke (Heinrich), Ausgewalte Novellen und Dichtungen von, Vierte vollständige Original-anflage. 16 voll. 8vo. *Aarau* 1839

Zschokke (Heinrich), Eine Selbstschau.
Erster Theil: Das Schicksal und der Mensch.
Zweiter Theil: Welt-und Gottanschauung.
8vo. *Aarau* 1843

Zumpt (C. G., Dr.), Lateinische Grammatik. Neunte Ausgabe. 8vo. *Berlin.* 1844

(Signed) EDW. RICHARDS PUREFOY COLLES, *Librarian.*

Sept, 30, 1871.

BOTANIC GARDEN.

HIS EXCELLENCY SIR JOHN YOUNG, *Governor-General of Canada, Government House, Ottawa*:—95 packages of Seeds.

JAMES O. BELL, Esq., 21, *Suffolk-street*:—Package of Seeds from New Zealand.

J. D. HOOKER, M. D., C. B., *Director, Royal Gardens, Kew*:—27 new and very valuable Plants.

MESSRS. VEITCH, *Royal Exotic Nursery, King's-road, Chelsea*:—30 new and valuable Plants.

DR. WILSON, *Westbury, Stillorgan*:—Large parcel of different kinds of Orchids without names, or any other information concerning them (*valuable*).

J. SMITH, Esq., *Curator, Botanic Garden, Kew*:—Cuttings of 15 kinds Mesembryanthemum and Plant of Ouviranda fenestralis.

MISS ANNE PETTIGREW, 24, *Montpellier-hill*:—Plant of "Loquat."

JAMES M'NAB, Esq., *Royal Botanic Garden, Edinburgh*:—15 kinds of rare Plants.

MAX LEICHTLIN, *Carlsruhe, Duchy of Baden*:—16 rare and new kinds of Liliums, with two other kinds of bulbs. (This is a *valuable* donation, made under considerable difficulties at the present time.)

JAMES NIVEN, Esq., *Curator, Botanic Garden, Hull*:—97 species of rare herbaceous Plants for botanical arrangement.

MISS CARROLL, 50, *Lower Leeson-street*:— A number of large bulbs from Cape of Good Hope.

MISS HAMILTON, *Greytown, Nicaragua, Central America*:—Box full of Plants, Seeds, and ornamental articles for Botanical Museum.

J. TYREMAN, Esq., *Curator, Botanic Garden, Liverpool*:—65 species of hardy herbaceous Plants, Ferns, &c. Also an assortment of new Bedding-out Plants, Pelargoniums, &c.

DR. SCHOMBURGH, *Director, Botanic Garden, Adelaide*:—40 kinds of rare Seeds from South Australia.

H. W. THOMPSON, Esq., *Viceregal Lodge, Phœnix Park*:—Large parcel of mixed Seeds from the Himalayas.

MR. TYREMAN, *Botanic Garden, Liverpool*:—30 packages of Seeds.

GENERAL HORACE CAPRON, *Commissioner of Agricultural Department, Washington, U. S. America*:—12 packages of Seeds of rare American Trees and Shrubs.

DR. WILSON, *Finglas*:—12 kinds Australian Seeds.

DR. HOOKER, *Royal Gardens, Kew*:—78 packages of Seeds.

REV. J. E. LEEFE, *Cresswell Vicarage, Morpeth*:—18 kinds of Cuttings of Willows.

J. TYREMAN, Esq., *Curator, Botanic Garden, Liverpool*:—20 packages of Seeds.

GENERAL CAPRON, *Commissioner of Agricultural Department, Washington, U. S. America*:—A *valuable* selection of Seeds, consisting of 40 large packages collected in America.

J. SMITH, Esq., *Royal Gardens, Kew*:—Young Plant of Victoria regia.

DR. CASPRAY, *Director, Botanic Garden, Konigsberg*:—80 packages of Seeds.

M. ORTGIES, *Inspector, Botanic Garden, Zurich*:—40 kinds of Seeds.

HERR BOUCHE, *Inspector, Botanic Garden, Berlin*:—52 packages of Seeds.

MISS CLARK, 4, *Botanic-view, Glasnevin*:—Package of Australian Seeds.

MISS HAMILTON, *Greytown, Nicaragua*:—Box filled with Orchidaceous Plants, and some Aroidaceous Plants, mixed.

H. HILLIER BAILY, Esq., *Geological Survey Office*, 14, *Hume-street*:—Parcel of Seeds from New Zealand.

General Capron, *Commissioner of Agriculture, Washington, U. S.*:—Large parcel containing 14 large packages of Seeds.

Traherne Moggeridge, Esq., 32, *Southwark-street, Paddington, London, W.*:—Two papers of rare Seeds.

Edward Wilson, Esq., 21, *Russell-place, Dublin*:—One Kaffir Necklace and two Kaffir Rugs, three sections of Woods for Botanic Museum.

Miss Birch, 7, *Tivoli Terrace, Kingstown*:—One parcel of Seeds.

Dr. Mueller, *Director, Botanic Garden, Melbourne, Australia*:—36 papers of Seeds.

D. J. Schomburgk, *Director, Botanic Garden, Adelaide, Australia*:—95 papers of Seeds.

Herr Wendland, *Director, Botanic Garden, Herrenhausen, Hanover*:—27 rare Plants, including Palms and Cycads.

W. Jameson, Esq., *Superintendent Botanic Garden, Saharumpore, E. Indies*:—2 large parcels of Seeds.

Hean Watts, Esq., *Commissioner of Agricultural Department, Washington, U. S.*:—2 parcels of Seeds.

Dr. Hooker, *Royal Gardens, Kew*:—22 species of rare Plants.

Herr Meyer, *Curator, Botanic Gardens, Carlsruhe, Duchy of Baden*:—15 species of rare Plants.

Herr Max Leichtlin, *Carlsruhe*:—Some valuable Bulbs of several kinds of Liliums, &c.

Herr Ortgies, *Inspector, Botanic Garden, Zurich*:—60 species of rare Plants.

——Verner, Esq., *Mount Merrion, Co. Dublin*:—Large parcel of the newer kinds of Pelargoniums and other bedding-out Plants.

William Wilson Saunders, Esq., *Hillfield, Reigate*:—Selection of Agaves, Bulbs, and Orchids.

J. Traherne Moggeridge, Esq., *Maison Gastaldy, Mentone, Alps Maritimes, France*:—2 parcels of Seeds.

Capt. Hamilton, 107th Regt., *Dum-Dum, Calcutta*:—7 large parcels of Seeds.

Herr Max Leichtlin, *Carlsruhe, Baden*:—Parcel of hardy Plants.

Dr. Thornton, 109th Regt., *Roorkee, Central India*:—9 parcels of Seeds.

Charles Ensor, Esq., 4, *George's-place, Dublin*:—6 packages of Seeds from Japan.

Dec. 36, 1871. David Moore, *Director.*

NATURAL HISTORY MUSEUM.

Chaworth Ferguson, Esq., 101 *Baggot-street*:—A Ringed Snake (*Natrix torquata*), captured in North Wales.

Captain Dover, *Castleconnor, Ballina, County Mayo*:—A pair of Shoveller Ducks (*Spathulea clypeata*), male and female; shot near Castleconnor.

Major George Close, per Rev. Maxwell Close, *Blackrock*:—Horns of the Barking Deer (*Cervulus aureus*), and of the Beni-Israel Antelope (*Neotragus saltianus*).

Captain Cane:—A Dutch Engraving, representing the capture of a Whale.

Charles Phineas Riall, Esq., *Old Conna Hill, Bray*:—A pied variety of the Norway Rat and an immature Jackdaw.

C. J. H. Tardy, Esq., *Aughnamullen Rectory, Ballibay*:—A pied Blackbird.

S. R. Fetherston H., Esq., *Eccles-street*:—A few specimens of British Lepidoptera.

Captain Dover, *Castleconnor*:—A fine male Eider Duck (*Somateria mollissima*), in nearly perfect summer plumage.

Sandford Palmer, Esq., J. P., *Ballinlough, Roscrea*:—A large Cat, and a female Wigeon (*Mareca Penelope*).

Mr. W. Williams, 3 *Dame-street*:—A fine specimen of *Terebratula Australis*.

Royal Zoological Society:—A young specimen of the Sandy Ray, (*Raia radula.*)

Professor E. P. Wright, M. D., 5, *Trinity College*:—A number of marine animals collected by himself in Sicily.

W. Corbet, Esq., *Castleconnell*:—An Iceland Falcon (*Falco islandicus*).

R. D. Hime, Esq., *Bengal Civil Service*:—Sixty-four Birds' Skins, collected by himself at Tipperah, Bengal.

W. Kane, Esq., *Drumreaske House, Monaghan*:—A few Carboniferous Fossils from Drumbrin Quarry, Co. Monaghan.

Arthur Huband, Esq., 7, *Herbert-street, Dublin*:—A necklace made of shells from Terra del Fuego; and a piece of tesselated pavement from ancient Carthage.

J. R. Garstin, Esq., 31, *Merrion-street*:—A specimen of the common Plated Crab (*Galathea strigosa*).

Sir Dominic Corrigan, Bart.:—The Head and Horns of a Gnu; Horns of the Koodoo Antelope, and of the Cape Buffalo; and two Malay hats.

L. De Teissier Prevost, Esq., 47th *Regiment* :—A collection of Butterflies from Trinidad.

W. Corbet, Esq., *Castleconnell* :—A fine specimen of the Kaleege Pheasant (*Gallophasis melanotus*).

W. Andrews, Esq., *Ashton, Monkstown* :—A specimen of the Anchovy (*Engraulis encrasicholus*) taken in Dingle Bay, this being the first known instance of its occurrence in Ireland.

Captain Dover, *Keswick* :—A fine specimen of *Zaphrentis cylindrica*, and other Carboniferous Fossils, from Ballisodare, Sligo.

G. R. Crotch, Esq., *University Library, Cambridge* :—A number of rare British *Coleoptera*.

J. Buchanan White, M. D., *Perth* :—Specimens of British Insects of various orders.

Reginald Cusack, Esq., *Ruby Hall, Monkstown* :—A specimen of *Nereilepas fucata*, taken in Dublin Bay.

Lieut.-Col. Maguire :—A beautiful carved model of a Chinese Josshouse from Amoy (deposited).

Lord Castlerosse, *Killarney*:—A fine specimen of the Red Deer (*Cervus elaphus*), shot near Killarney.

The Rev. B. J. Clarke, *Lisavalley Rectory, Barnaderg* :—Five specimens of native Birds, stuffed.

Sir Victor Brooke, Bart., D. L., *Brookeborough, Co. Fermanagh* :—A number of Birds' Skins collected in Italy.

C. Fleming, Esq., M. D., 6, *Merrion-square* :—A Virginian Nightingale (*Cardinalis Virginianus*).

Captain Barton, R. N., *Stone House, Donnybrook* :—A Lizard and two Beetles from the Cape of Good Hope.

R. Templeton, Esq., M. D., *Hibernian School* :—A series of native Spiders preserved in spirits.

Captain Boxer, R. N. :—A white variety of the Common Puffin.

T. M'Mahon, Esq., 4, *Clarinda Park, Kingston* :—An Indian Knife.

Earl of Enniskillen, *Florence Court* :—A nest of the *Vespa Britannica*.

Colonel Sir A. P. Phayre, K. S. I. :—The Heads and Horns of several species of Deer, Antelopes, Ibex, and Mountain Sheep, from Cashmere.

Robert Warren, Esq., Jun., *Moyview, Ballina* :—A fine specimen of the Eider Duck shot near Killala; a number of Twites, and a Grey Plover.

Sandford Palmer, Esq. :—A very fine Head and Horns of the domestic Goat *Capra hircus*.

H. M. Anderson, Esq., *Natal* :—A fine specimen of the nest of a Trapdoor Spider, and of the Spider itself.

WILLIAM ANDREWS, Esq., *Aston, Monkstown, Co. Dublin*:—An incomplete Skeleton of Ziphius Sowerbiensis, which had been stranded in Brandon Bay, Co. Kerry, this being the second specimen taken in Ireland.

COLONEL ASTON, 8, *Portland Place, Bath*:—A few Shells collected by himself at Kalk Bay, Cape of Good Hope.

REV. E. TARDY, J. P., *Aughnamullen Rectory, Ballibay*:—A Grey Phalarope, shot at Aughnamullen, Co. Monaghan, on October 20, 1870.

SIR RICHARD GRIFFITH, Bart., V. P., R. D. S., *Fitzwilliam-place*:—A series of Carboniferous Fossils, collected under his direction in Ireland.

MISS O'BRIEN:—A small collection of Echinodermata, from the coast of Clare, including *Luidia-Savignii, Goniaster-Phrygianus*, &c.

DR. BEATTY, 62, *Lower Mount-street*:—A Sand Grouse, *Pterocles alchata*, from India.

CAPTAIN DOVER, *Castleconnor, Ballina*:—The skull of a Grampus (*Orca gladiator*), killed in the estuary of the Moy, and some Turnstones (*Strepsilas interpres*), and purple Sandpipers (*Tringa maritima*), in an interesting condition of plumage.

WILLIAM ANDREWS, Esq., *Monkstown*:—Four specimens of the very rare fish, *Trichiurus lepturus*, collected in Brandon Bay, Co. Kerry.

G. R. CROTCH, Esq., *University Library, Cambridge*:—Some foreign Beetles belonging to the family *Coccinellidæ*.

G. K. S. MASSY DAWSON, Esq., *Ballinacourte, Tipperary* (through PHINEAS RIALL, Esq.):—A very fine specimen of the American Goshawk (*Astur atricapillus*), shot at Ballinacourte, Co. Tipperary, this being the first instance of its occurrence in Ireland.

HERR PROFESSOR DR. JAPETUS STEENSTRUP, *University, Kobenjavn, Denmark*:—A plaster cast of the skull of the Dodo (*Didus ineptus*).

EDWARD WALLER, *Aughnacloy, Co. Tyrone*:—Some specimens of the rare land shell, *Acme fusca*.

CAPTAIN NEEDHAM, *Westwood, Cahirciveen*:—Various Ethnological and Natural History specimens, collected by himself in India, Egypt, and other countries.

CAPTAIN DOVER, *Castleconnor, Ballina*:—Several Sanderlings (*Calidris arenaria*), and Purple Sandpipers (*Tringa maritima*); also some specimens of the Brown Trout taken in saltwater at Ballisodare, and a Sea Trout, *Salmo cambricus*.

W. W. MCCGUIRE, Esq., *Clonea House, Dungarvan*:—A fine specimen of the Ruddy Shieldrake (*Tadorna rutila*), shot near Clonea House, Waterford.

PROFESSOR W. T. DYER, *Royal College of Science*:—A small collection of Oolitic Fossils.

SIR VICTOR BROOKE, Bart., *Colebrooke, Brookeboro, Fermanagh*:—An immature specimen of Bewick's Swan (*Cygnus Bewickii*).

A. BASIL BROOKE, Esq., *Colebrooke*:—A fine adult specimen of the Grey-legged goose (*Anser ferus*), shot on the Murrough of Wicklow.

A. LEITH ADAMS, M. D., *Surgeon-Major 22nd Regiment*:—A specimen of the Silvery Hair-tail *Trichiurus lepturus*, taken at Kinsale, being the first captured in Ireland.

H. BLAKE KNOX, Esq., J. P., *Dalkey*:—Some specimens of the Greenland Bull-head (*Cottus groenlandicus*), taken in Dublin Bay.

JOHN O'NEIL, Esq., 19, *Bywater-street, Chelsea*:—A coat made of Birds' Skins, from Port Clarence.

SANDFORD PALMER, Esq., *Ballinlough, Roscrea*:—A specimen of the Snake Rat (*Mus tectorum*), taken at Ballinlough.

THOMAS E. BEATTY, M. D., *Mount-street*:—A stuffed Peacock from India.

H. KELSALL, Esq., 23, *Waltham-terrace, Blackrock*:—A few Birds' Eggs from Trinidad.

A. H. M'CLINTOCK, M. D., 21, *Merrion-square*:—A Bat (*Phyllostoma*), from Demerara.

Miss WHITLEY, 15, *Harrington-street*:—An Ammonite, and a Clay Nodule from the Lias formation.

WILLIAM A. RIALL, Esq., *Royal Artillery, Old Conna Hill*:—A Merlin (*Falco æsalon*), shot on the Sugar-loaf Mountain, Wicklow.

MRS. MINCHIN:—A black-backed Gull (*Larus dominicanus*), and a Stilt Plover, from New Zealand.

JAMES ROYSTON, Esq., *Athlone*:—Two Eggs of the red-breasted Merganser; one Egg of the Little Grebe, from Lough Ree; and a Great Northern Diver.

R. P. WILLIAMS, Esq., *Dame-street*:—A Gosling of the Ashy-headed Goose (*Chloephaga poliocephala*).

A. P. ALLEN, Esq. 9, *Lower Sherrard-street*:—A piece of native-manufactured Matting, from the Islands of Marquesas.

HENRY WOODWARD, Esq., *British Museum*:—A cast of *Astropecten Cottswoldiæ*.

J. G. ROBERTSON, Esq., *Prior's Orchard, Kilkenny*:—Fifty Birds' Skins from various localities, and a few other specimens of Natural History.

WILLIAM TALBOT, Esq., *Tarbert, Kerry*:—A few indigenous *Lepidoptera* taken near Tarbert.

R. D. HIME, Esq., *Bengal Civil Service*:—Twenty-nine Birds' Skins from India.

ROBERT WARREN, Esq., Jun., *Moyview, Ballina*:—Five specimens of the Redshank, *Totanus calidris.*

SIR FRANCIS BRADY, Bart.—A Neptune's Cup Sponge (*Raphophora patera*).

MR. T. S. WRIGHT, 78, *Lower Mount-street*:—Three Dresses made from the bark of a tree called "Tappa," and worn by the natives of the Fiji Islands; also two Fans made from the leaves of the Cocoa-nut Palm.

MAURICE FITZGERALD, Esq., *The Palace, Killaloe*:—Specimens of Boracite, Borochloride of Magnesium, from Lüneberg, Hanover.

DR. R. TEMPLETON, *Royal Military School*:—A few Reptiles and Fish from Ceylon.

J. K. MILLNER, Esq., *Blackrock*:—A short-eared Owl.

MISS C. H. STEPHENS, 4, *Blackhall-place*:—A Cuttle-fish.

ROBERT H. SCOTT, Esq., F. R. S., *Meteorological Survey*:—Specimen of Meteoric Iron from a large block weighing 25 tons, brought from Ovifak, Disco Island, Greenland, by Professor A. E. Nordenskjold; also a specimen of Kryokonite from the inland Ice of Greenland, 30 miles from the edge, and 2000 feet above the sea, brought home by Professor A. E. Nordenskjold.

B. B. LABREY, Esq., *Didsbury, Manchester*:—Two bottles containing Insects preserved in spirit, and a few foreign *Lepidoptera.*

R. S. FEATHERSTON HAUGH, Esq., 17, *Eccles-street*:—A Snow Bunting shot at Glenmore, near Crossmolina, Mayo, on the 30th September, 1871.

G. WILLIAMS, Esq., 5, *Charleston-road, Rathmines*:—A Sea-snake, *Pelamis bicolor*, captured in the Indian Ocean 200 miles from land.

BAGOT BLOOD, Esq., 38, *Wellington-road*:—Skin of Man-eating Tiger; a Lynx and a small Wild Cat; Skull of Indian Black Bear; a large Hornbill; an immature *Lammergeyer*, &c., all from India.

C. STEPHEN VOYSEY, *Ringsend*:—A fine specimen of the Stony Foliaceous Coral, *Eschara foliacea*, from Kinsale.

MRS. BATTERSBY, *Cromlyn, Rathowen, Westmeath*:—Specimens of *Bombyx Yama-mai*, and of *B. Pernyi*, reared in Ireland.

F. H. NASH, Esq., 20, *Blessington-street*:—A white Missel Thrush, shot in Co. Galway.

EDWIN BIRCHALL, Esq., *Airedale Cliff, near Leeds*:—Two Stoats and a Weasel, from Yorkshire.

SIR JOHN DILLON, *Lismullen*:—A pair of the great Indian Bustard (*Eupodotis Edwardsi*), and a Crane (*Grus cinerea*), from India.

Rev. W. A. Flemyng, *Milltown, Dublin* :—A few Shells and Minerals.

F. S. Y. Adams, Esq., M.D., R. N.—Rock specimens, &c., from the Diamond districts, South Africa.

Madame E. Verreaux, *Paris* :—A skull of Monkey (*Cebus capucinus*), separated and mounted *a la* Beauchene.

Master Bewley, *Willow Park, Booterstown* :—The skin of an immature Albatross, shot off Cuba.

Alexander Carte, M. D., F. L. S., *Director*.

Dec. 30, 1871.

INTELLIGENCE.

ROYAL DUBLIN SOCIETY'S SCHOOL OF ART.

The Annual Meeting for the distribution of Prizes to the Students of the Art School took place in the Lecture Theatre of the Society on the evening of Wednesday, February 22nd. The attendance was very large. Shortly after 9 o'clock His Excellency the Lord Lieutenant, accompanied by the Marquis of Hartington, Chief Secretary, and attended by H. Y. Thompson, Courtenay Boyle, and Captain Villiers, A. D. C., arrived, and was received by Vice-President Colonel Adamson, Chairman of the Committee of Fine Arts, George Woods Maunsell, D.L., Lord Clonbrock, Secretary, by whom His Excellency was conducted to the Chair, which he occupied as President of the Society.

G. Woods Maunsell, D. L., Secretary, said it became his duty to open the proceedings of the evening, and call His Excellency's attention to the subject of distribution which they had assembled to celebrate. On former occasions he had performed a like office in presence of His Excellency, whom every year they, of that Society, were finding more attached to them, and inclined to use his distinguished position to forward all those great objects for which they were associated. Not the least important of those objects is the fostering of Art in this country, and not the least successful department of their Society was that which had reference to the progress of Art, as seen in these schools. He might state, not for his lordship's information, but rather for the information of others present, that there was held every year in London, under the auspices of the Department of Science and Art, an examination of all the Art Schools of the United Kingdom. That examination took place in various forms—both locally by examination of students, and at South Kensington by the examination of works, the result of which was given to the public in a printed report, issued by authority. He had received the last of these documents, and, having analysed it with pains, had found its details highly creditable both to the masters and pupils of their school. He much regretted to be obliged to refer to the absence of the Head Master, Mr. Lyne, who by a sad bereavement which has suddenly taken place in his family, is prevented from being here this evening. Before stating these results he might mention that the awards made were of various descriptions. The first, and most important, were what are termed National awards. There were then Queen's prizes, which might count 1; bronze medals, 2; silver medals, 4; and gold medals 6 in relation to the unit or Queen's prizes. Keeping that tabulation in view, he found they, in Dublin, had obtained upon that scale no less than 26 marks, or, in precise numbers, 19 awards—6 Queen's prizes, 4 bronze, and 3 silver medals. Going

through the several schools of South Kensington, Nottingham, Manchester, London (except South Kensington), Edinburgh, Birmingham, Glasgow, and Liverpool, it would be seen that Nottingham stood first on the list of National awards, South Kensington second, and Dublin third. It was in the highest degree creditable that a school of lesser numbers—for Nottingham had only 400 pupils—should occupy so high a position, standing even before South Kensington; but that, to a great extent, was accounted for by the fact that in the town there was conducted on an extensive scale a branch of manufacture which required a highly cultivated art-taste to sustain it. Turning, however, to a comparison of the number of works sent for exhibition, in relation to prizes gained, what was the result? Dublin sent up 392 works, and obtained 29 prizes, or 1 in 13, being the highest average of all the nine schools already named; South Kensington being next, with 692 works and 42 prizes, or 1 in 16. In third grade prizes, the pupils of South Kensington ranked first, and Dublin second; and in the second grade, Edinburgh was first, having obtained prizes for 31 per cent. of the works exhibited; whereas Dublin obtained 29 per cent., the lowest mark being 10 per cent. Summing up all these figures, and taking the lowest as representing the highest excellence, Dublin represented 8; South Kensington, 10; Nottingham, 15; Manchester, 20; London, 21; Edinburgh, 21; Birmingham, 24; Glasgow, 28; and Liverpool, 32. They were thus entitled to claim at the hands of the public great praise for the honourable position they were enabled to fill, and that notwithstanding the greater advantages held out to the students attending at South Kensington, at Edinburgh, and he might add at all the other schools, by means of their readier access to the English Art Museum. He might remind His Excellency and the Chief Secretary—who sat beside him—that the melancholy ocean rolled between England and Ireland, and that they had not the same opportunity of studying in the noble school of Kensington which even the sister institutions of England had, and they would forgive him if he expressed a hope that their lordships would press upon the Government the peculiar position of this country in that respect, with the view of obtaining for that school and for Ireland something like a separate grant, out of which they could create and maintain a separate Museum. They had, he thought, something like a historic claim upon the kindness of the noble Secretary. It was only about six years after the Society was formed that a noble ancestor of his (the Duke of Devonshire) filled the office of Lord Lieutenant of Ireland, and, if he mistook not, was one of the first Presidents of the Society. Possibly they might live to see that repeated in the present generation—a noble lord of the same family fill the high position now occupied with so much credit to his country and honour to themselves by Earl Spencer; but it was now, when he sat in the House of Commons, that his voice was specially powerful; and he (Mr. Maunsell) was glad of his presence that night, and of his being able to address these remarks to his consideration. He believed that a reference to the parliamentary estimates would show that the School of Edinburgh was treated exceptionally from all other kindred institutions. They did not complain of the grant to Edinburgh, but only asked to be similarly dealt by. Again, for many years they had pressed upon the Government that some steps should be taken towards establishing a Museum of Art in this country; and without the advantages which are derived from a Museum, and, without such opportunities as are given to the Edinburgh pupils, it was hardly possible that they should continue successfully to compete with London or Edinburgh. He would not detain His Excellency longer, but conclude by asking his kind attention and the attention of the Chief Secretary to the several matters dealt with in the report.

Lieutenant-Colonel Adamson, Chairman of the Fine Arts Committee, congratulated the Society on the distinguished honour conferred on them by the presence of the Lord Lieutenant and Marquis of Hartington. He corroborated Mr. Maunsell in what he stated as to the great necessity for the establishment in Ireland of a Museum of Ornamental Art, and the necessity of Government

making some provision by way of Grant to enable their Students to attend at the great Kensington School of Art. He would now read the Report of the School for the year ending July 30, 1870:—

The Committee of Fine Arts, in making their Report on the state and progress of the School of Art, have to congratulate the Royal Dublin Society upon its present degree of efficiency, and on its very remarkable success when competing with the Schools of the United Kingdom; and refer with especial pleasure to the highly satisfactory results of the past year, and more particularly to the honourable and distinguished position occupied by the Society's School in the last National Competition.

The steady progress that has characterized the operation of this Art School ranks it among the best in the United Kingdom.

The general excellence, apparent in works of all stages, evidenced judicious and skilful instruction of the highest order, having for its aim the complete realization of natural forms and effects.

The present Report represents the working of the School for the year ending July 31st, 1870. Heretofore the School Year terminated on the 31st of December. This change is due to a recent arrangement of the Department of Science and Art.

The total number of Students who have attended during the year, ending July 31st, has been 594, showing an increase of 59 over the numbers of the preceding year.

The total number attending for the year ending 31st December, was 616, showing an increase of 78.

Of the 594 Students attending during the year, ending the 31st July, 286 were males, and 308 females.

The attendance of Artisans has been 496, of which 272 were males and 224 females.

The receipts in fees amounted to £524 4*s.* 7*d.*

The greatest attendance of Students took place in February, and was smallest in April.

The average daily attendance amounted to 120.

The following is an analysis of the occupations of Students or their parents:—

Professional,	423
Artists and Art Teachers,	26
Merchants, Salesmen, &c.,	31
Civil Servants,	16
Unclassed,	62
Land Proprietors,	36
Total,	594

The annual local Examinations of the Second Grade, took place on the evenings of the 10th and 11th of March, when 177 Students presented themselves, out of which number, 99 Students, consisting of 53 males, and 46 females, succeeded in passing Examinations in 159 papers; having for subject—Freehand Drawing, Model Drawing, Perspective, and Practical Geometry.

The Table appended shows the relative success of the male and female Students in the four subjects of examination, the number of exercises "passed" for which certificate cards are given, and the number of papers marked "excellent," for which prizes have been awarded.

BY MALE STUDENTS.

	Freehand.	Geometry.	Perspective.	Model Drawing.		Total.
Passed,	22	8	8	11	=	49
Excellent,	12	17	10	5	=	44
Totals,	34	25	18	16	=	93

BY FEMALE STUDENTS.

	Freehand.	Geometry.	Perspective.	Model Drawing.		Total.
Passed,	17	9	6	13	=	45
Excellent,	8	5	7	1	=	21
Totals,	25	14	13	14	=	66

To each Exercise passing "Excellent," a prize is awarded, but two or more prizes gained by the same Student are represented by one award, consequently the 65 prizes gained at this examination are represented by 52 awards.

The following Students are worthy of honorable mention in this Report, as having each passed in the whole of the four subjects of Examination on the occasion, viz.:—

Walter Ashby Adams, Joseph H. Beardwood, John M'Donnell, and Eleanor Carr.

It is gratifying to have to remark upon the steadily increasing interest displayed by Students in these local Examinations, and upon the earnest manner in which they endeavour to qualify themselves for them.

The Examination, conducted entirely by time exercises of one hour each, demands much ability and ready execution as far as elementary work is concerned. Two of the subjects, Geometry and Perspective, are worked with Instruments, the other two subjects being executed Freehand. In the subject of Model Drawing, some common or familiar object is given. On the last occasion the Exercise consisted of a kitchen chair, having a washing bason and ewer placed upon its seat.

The following Members of the Council, and of the Fine Arts Committee of the Society, attended during the Examination, viz.:—

Lieut.-Col. Adamson, Wm. M'Kay, LL. D.; Judge Kelly, LL. D.; Henry Dix Hutton, Dr. Evory Kennedy, Dr. Thornhill, Dr. Barker.

By a recent minute of the Lords of the Committee of Council on Education, the date of the local Examinations will in future be the month of May instead of March, as heretofore.

On the 9th day of April the works in the various stages of Art Instruction were forwarded to London, such works being divided into two sections—the Elementary and Advanced.

Works of the Elementary section compete for "Third Grade Prizes," having the same value as the "Local Medals" formerly awarded, but discontinued in 1866.

The Advanced Works only are eligible for the National Competition, the awards made in which are limited in number, and represent the highest distinctions attainable.

The Works forwarded by these Schools consisted of 49 Works by 31 Students in the Elementary Section, and 130 Works by 36 Students in the Advanced Section.

In addition to the above, 246 Ordinary Class Drawings, consisting of Outline of Figure, Ornament, Models, Geometry, Perspective, Projection, &c., were forwarded, making a total of 425 Works executed by 200 Students.

To the Drawings of the Elementary Section, competing for "Third Grade Prizes," 31 awards were made to 29 Students, being an increase of 9 over the number awarded last year in the corresponding Competition.

To the Advanced Works, alone eligible to enter into the National Competition, 16 awards to 13 Students were made; *being a greater number than have, upon any previous occasion, been gained by this School, notwithstanding its very marked success in former years.*

A list of the various Works distinguished in the National Competition, together with the names of those Students by whom they were executed, is as follows:—

NATIONAL AWARDS.

Miss Frances Brett, for Carpet Design Silver Medal.

Miss Frances Brett, for Muslin Curtains, Silver Medal.

Miss Frances Seymour, for Flowers, painted from Nature in Water Colours, Silver Medal.

Miss Kate Seymour, Designs for Muslins, Silver Medal.

Miss Dorothy Maria Webb, Group in Oil Colours, Bronze Medal.

Miss Dorothy Maria Webb, Female Head, painted from the Life in Oil, Bronze Medal.

Mr. Edmund Ripton Byrne, Group in Oil Colours, Bronze Medal.

Miss Kate Seymour, Female Head, painted from the Life, in Oil, Bronze Medal.

Miss Eliza Irwin, for Muslin Curtains, Bronze Medal.

Miss Phebe A. Moss, for group in Oil,* Queen's Prize.

Miss Elizabeth Wallace, for Muslin Designs, Queen's Prize.

Miss Kate Seymour, for Wall Decorations, Queen's Prize.

Miss Kate Seymour, for Study of Female Head from the Life, in Oil, Queen's Prize.

Hon. E. Plunket, for Wall Diaper, Queen's Prize.

Miss Kate O'Brien, for Bust of Girl, from Life, Queen's Prize.

Robert S. Smith, for Bust of Apollo, Queen's Prize.

The Examiners were—Sir M. D. Wyatt; C. W. Cope, R. A.; J. C. Horsley, R. A.; R. Westmacott, R. A.; James Ferguson, F. R. S.; E. J. Poynter, R. A.; R. Redgrave, R. A.; and H. A. Bowler, Official Inspector.

The position occupied by the Dublin School, as compared with the five most important Schools in the United Kingdom, will be seen in the following Table:—

	National Awards.
Dublin, 16 Prizes to 13 Students, and represented by,	13
Edinburgh (Male School),	8
Do. (Female do.),	2
Manchester,	8
Glasgow,	4
Liverpool,	2
Birmingham,	1

The Schools of Art in the United Kingdom amount to upwards of 100; the number of Schools that have gained National *Medal* awards, from 1866 to 1870, inclusive, is as follows:—

	No. of Schools gaining National Medals.
1866,	31
1867,	29
1868,	31
1869,	28
1870,	27

* The Queen's Prize has the same value as the National Medallion, awarded up to the year 1865, which was then the highest award offered to Students of Schools of Art.

The Sixteen Works successful in the National Competition will be exhibited at the forthcoming International Exhibition, to be held in London, in 1871.

To Mr. Edwin Lyne, the Head Master of the Society's Schools, one of the Bonuses, offered by the Department of Science and Art for successful management and teaching, was given.

Season Tickets were presented to the three Silver Medallists, viz., Miss Frances Brett, Miss Frances Seymour, and Miss Kate Seymour, by the Council of the Royal Academy of London.

A Free Studentship in the Dublin Schools, held during the previous year by Mr. Edward Gibson, a student of much promise, was recommended by the Department to Mr. Sylvester Reilly, who is in every respect worthy of this distinction; Mr. Reilly having displayed, up to the present time, much earnestness and ability.

In March, the Fine Arts Committee of this Society allowed a Free Studentship to Miss M. A. M'Gee, whose great industry and rapid progress in every way justify the selection.

In a Competition for Prizes offered by the Worshipful Company of Plasterers of London, for a Design, in Monochromo, for a Wall Diaper, the Hon. E. Plunket succeeded in obtaining one of the two awards.

A design of very considerable merit, also for Wall Diaper, and forwarded to the same competition, by Mr. Thomas Scott, was purchased, with a view to manufacture, by Samuel Hubert, Esq., the chief promoter of the Prizes offered by the Plasterers' Company.

As a means of stimulating a new branch of industry, specially available for the employment of educated females, the Lords of the Committee of Council on Education, in July last, offered eleven Money Prizes of £6 and £5 each, for the best Designs for Fans, painted on a material suitable for Fan Mounting; a selection from them to be exhibited in the International Exhibition of 1871.

In connexion with this competition, a loan of nine Fan Designs was made to the School of Art, by the Department of Science and Art; intended chiefly for study and reference by the Students, they were also available for public inspection during a period of four weeks. These designs were purchased in the Universal Exhibition of Paris, in 1867, and were the productions of the following Artists—viz., E. de Beaumont, Croun, Henri Picou, E. Froment, and Mdme. Callamatta.

Seven of our Students—viz., Miss A. M. A. M'Gee, Isabella Maffett, Elizabeth Irwin, Frances Brett, Elizabeth Todd, Phebe Annie Moss, and Marianne Morgan, executed ten Fan Designs, which were forwarded, on the 15th December, for Competition.

Mr. Edward T. Dresden has offered to the Schools generally, through the Department of Science and Art, Five prizes of £10 each, for the following subjects, and we trust that our Students will respond to these liberal offers:—

For the best Modelled Vase, ...	£10
A further prize for the best treatment in Colour and full Decoration of same, ...	10
For the best design for a Dessert Service made in outline and Water Colours, ...	10
A further prize for the best execution of the same in Pottery, ...	10
The prize for Painting one representative piece of each part of the service must be executed, ...	10
A prize for the best set of "Plaques," not less than four, for the decoration of a Cabinet. Size of Plaques to be —two rectangular, 10 inches high by 7 inches wide; two oval, or elliptical, upright, 10 inches high by 8 inches wide, ...	10

The works in competition to be forwarded to London on the 10th day of February, 1871, may be executed by male or female Students.

A Design executed by Miss Charlotte Kenny was, a short time since, purchased by Messrs. Templeton, the eminent Carpet Manufacturers of Glasgow.

Six Designs for Wall Decoration, Chintz, &c., executed by Miss Minnie Mahony, have also been purchased by Daniel Lee, Esq., of Manchester.

Messrs. Walpole, of Suffolk-street, Dublin, having offered two Prizes of £4 and £2, for the two best designs for Muslin Curtains,

Fourteen Designs of great merit and semi-conventional character were produced by the following nine Students, viz.: Sylvester Reilly, Thomas Scott, Mary A. M'Gee, Bridget M'Gloin, Elizabeth Wallace, Elizabeth Irwin, Marcella Irwin, Frances Brett, and Minnie Mahony.

The Prizes were adjudged as follows:—

First Prize, £4, to Miss Minnie Mahony.
Second do., £2, to Miss Marcella Irwin.

Mr. Peter Sheridan, of Parliament-street, in order to encourage the application of Art to Manufacturing purposes, has offered a Prize of Two Guineas for the best Design for a Brussels or Wilton Carpet, the Competition to take place at Midsummer.

In June, Dr. Alexander Macalister gave a course of eight Lectures to our Students on Anatomy, and its application to the Fine Arts. At the termination of the course, an Examination was held with the following results:—

Two Silver Medals were offered by the Society.

Highest number of Marks attainable, . . 1000

	No. of Marks.
Miss Phebe Annie Moss, ...	872
Miss Kate O'Brien, Miss Ismena Benson, } equal. . .	730

The competition for the Silver and Bronze Medals offered by the Society took place on the 23rd December, Sir George Hodson, Bart., Thomas Alfred Jones, Esq., P. R. H. A., and Thomas Drew, Esq., A. R. H.A., acting as judges.

The following is a list of the Works in the various stages of Study submitted, 991 in number, and executed by 62 Students, of whom 25 were males and 87 females.

Human Figure Drawn, Painted and Modelled.

	No. of Works.
Full-length Antique, in Chalk, by Assistant Teachers,	3
Full-length Antique, in Chalk, by Students, . .	3
Heads, Hands, and Feet (Antique), . . .	9
Modelling in Clay, from the Life and Antique, .	5
Study of Heads, from Life, in Oil, Water, and Chalk,	10
Anatomical Studies, ...	3

Original Design for Manufacture.

Muslin Curtains, ...	14
Muslin Dresses, ...	8
Wall Diapers (Monochrome), ...	4
Wall Surface Decoration, ...	9
Carpets, ...	3
Altar Cloth, ...	1
Lace Designs, ...	5

	No. of Works.
Book Cover,	1
Fan Designs,	2
Mirror Frame,	1
Groups in Oil Colours and Chalk.	
In Oil Colours,	6
In Chalk,	13
Architectural and Mechanical Drawing.	
Architecture from Measurement,	3
Perspective,	4
Projection,	2
Geometry,	10
Landscape and Animals,	80
Total Number of Studies,	199

The Report of the Judges may be seen in the List of Distribution appended to this Report.

Tables, showing the leading results of the operation of the Society's School of Art for many years past, together with a list of Loans by the Department, of valuable Pictures, Books, and Photographs, relating to Art, are also appended.

Eyre Crowe, Esq., visited the School on November 2, 1869, and reported most favourably as to the advanced studies in progress.

At the recent Exhibition of Students' Works in the School of Art, open from the 26th of December, 1870, to the 6th of January, 1871, the number of Visitors was 5932, amongst whom was His Excellency the Lord Lieutenant.

At the Conversazione of the Royal Dublin Society, on the evening of the 1st of March last, the Works executed by our Students in Drawing, Painting, and Modelling, were arranged in the Library, and constituted a most interesting feature on that occasion.

In alluding to the great difference existing between this Metropolitan School and that of Edinburgh, which latter, owing to a special arrangement, possesses ample funds, whilst this important School, the leading Art Institution of Ireland, is dependent upon varying results, together with such aid as the Royal Dublin Society is enabled to extend to it, we cannot refrain from expressing our regret that, *in the absence of any Parliamentary grant, we are unable to extend our operations.*

In again, this year, referring to the desirability of establishing a Museum of Ornamental Art, in connexion with the Schools of this Society, we are, considering the difficulty and risks at present attendant upon obtaining those examples of Art necessary, led to an increased conviction of its urgent necessity.

By the addition of such a museum to our School, having for its object the promotion of Art in all its various branches in this country, and capable of aiding in a just comprehension of its contents, Art would be more fully brought to bear upon the wants and requirements of every-day life, and would tend to awaken more generally a taste for refined treatment in every kind of industry to which Art is applicable.

All those productions of modern times that have met with the greatest amount of success, may be said to have resulted, in a great measure, from the study of the masterpieces of the most distinguished epochs of historic times. Even the great Raphael was led to the execution of those chef d'œuvres of decorative skill, the arabesques of the Vatican, by the discovery of the Baths of Titus, the wall-paintings of which wrought so great an influence upon his creative mind.

The value of such a Museum, in connexion with the studies of our School, cannot be over estimated, encouraging, as it would, critical analysis, in order to penetrate the course of thought and motives which animated the inventors of the best periods, and thereby leading to emulation, but not necessarily to imitation.

It is by reference to those examples of the best periods, along with the study of nature through her higher forms, that the mind arrives at more extended views of Art, as a humanizing, moral or educational agent, and is led to a better appreciation of its legitimate aims and purposes; false and limited views and desultory study are then abandoned in favour of judicious practice and well-directed inquiry into those eternal laws, which, to a certain degree, philosophic investigation has succeeded in demonstrating—laws, whose gradually increasing application in our own time will ultimately force empiricism to give way before intelligent study.

In closing our Report, the Committee of Fine Arts of the Royal Dublin Society feel bound to call attention to the Report of the Judges who awarded the Prizes, and to express their high approval of the manner in which Mr. Edwin Lyne, M. R. I. A., the Head Master of the Schools, has conducted this great establishment, and of Miss Mary Julyan, and the other teachers.

REPORT

Of Judges of Works of Art Students.—Christmas, 1870.

Our recent inspection of the Works of the Students in the Art Schools enables us to confirm the favourable opinion expressed on former similar occasions, and to record our appreciation of the talent and application displayed in the several classes.

We have been particularly impressed by the excellence of the productions in the Department of Art, as connected with Manufacture, and more particularly by the inventive power and tasteful arrangement displayed in the specimens for Muslins, Wall Decoration, and Designs in Monochrome. The great advantage of encouraging this very important branch of Art Education leads us to suggest to the Fine Arts Committee the propriety of offering, in future, additional Prizes in this Class, provided the funds at their disposal permit such allocation—one Silver, and one Bronze Medal offering no sufficient recognition of the merit displayed in the praiseworthy designs submitted to us.

We cannot omit noticing, with the highest possible approbation, the promise of future excellence displayed in the Portrait Model by Miss Kate O'Brien.

In Class V., for Landscapes from Nature, in Oils or Water Colours, we regret being unable to make any award; the studies exhibited, although bearing evidence of attention to natural effect, being deficient in some of the leading principles required for proficiency in this department.

We cannot close our Report without recording our full approval of the evident anxiety, on the part of the Head Master, Edwin Lyne, Esq., to do justice to the Pupils under his care, and to the success which has attended the painstaking and conscientious discharge of his duties in directing their studies.

The following are our awards :—

Class I.—*Studies of the Human Figure.*

Sec.	Names.	Prizes.
1.	Mr. Robert Walshe, for his Drawing of Antinous, . .	*Special Silver Medal.*
	Mr. E. A. Byrne, for his Drawing of the Discobolus (recommended), ...	*Second Silver Medal.*
2.	Miss Isabella Maffett, for Drawing of the Milo Venus, in Chalk, ...	*First Silver Medal.*

Sec:	Names:	Prizes.
2.	Miss Emily Smyth, for Chalk studies of Head, Hand, and Foot (recommended),	*Second Silver Medal.*
3.	Mr. James M'Donnell, for Study of Female Head from life, in Oil,	*First Silver Medal.*
	Miss Maryanne Morgan, for Study of Female Head in Chalk, from the life (recommended),	*First Silver Medal.*
4.	Miss Kate O'Brien, for her Model from the Life, of Girl,	*Second Silver Medal.*
5.	Miss Olivia Poole, Anatomical Drawing,	*Second Silver Medal.*

CLASS II.—*Design for Manufactures.*

Miss Kate Seymour, for her Design for Muslins,	*First Silver Medal.*
Miss Frances Jordan, for Wall Decoration,	*First Bronze Medal.*
Miss Frances Seymour, for Plastic Design (Wall Diaper),	*Honorable Mention.*
Honorable E. Plunket, for Plastic Design (Wall Diaper),	*Honorable Mention.*
Mr. Silvester Reilly, for Design for Muslin Curtains,	*Honorable Mention.*
Miss E. F. Poole, for Wall Decoration,	*Honorable Mention.*

CLASS III.—*Architecture and Machine Drawing.*

1.	Mr. Richard Dowling, best Drawing of a Public Building from actual measurement,	*First Silver Medal.*
2.	Mr. G. W. Withers, for the best Sheet of Geometrical Drawings,	*First Bronze Medal.*
	And Mr. A. Scott,	*Honorable Mention.*
3.	Mr. J. H. Beardwood, for Isometric or Orthographic Projection,	*First Bronze Medal.*
4.	Mr. J. P. Beardwood, for Perspective Drawing,	*First Bronze Medal.*
	Mr. Albert Murray (recommended),	*Bronze Medal.*

CLASS IV.—*Drawing and Painting from Still Life, and Models.*

1.	Miss Maria D. Webb,	*First Silver Medal.*
	Recommended in place of the 2nd Silver Medal offered.	
	Miss P. Annie Moss,	*Second Silver Medal.*
2.	Mr. John Thomas Myles,	*First Bronze Medal.*
3.	Mr. G. W. Withers,	*Honorable Mention.*

CLASS V.—*Landscape and Animals.*

No award.

A bonus of £5 having been recommended by the Society to the Assistant Art Teachers for the best set of Drawings, consisting of outline of Models, Figure, and Ornament, such being the ordinary exercises of the Elementary Classes, we recommend that this bonus of £5 should be equally divided between Mr. E. Byrne and Mr. Robert Walshe.

GEORGE HODSON, BART.
THOMAS ALFRED JONES, P. R. H. A.
THOMAS DREW, A. R. H. A.

Royal Dublin Society School of Art,
23rd December, 1870.

ANATOMY EXAMINATION, HELD ON THE 1ST JULY, 1870.

Moss, Phebe A.,		*1st Silver Medal.*
O'Brien, Kate,	equal.	*2nd Silver Medal.*
Benson, Iamena,	equal.	*2nd Silver Medal.*

MESSRS. WALPOLE'S PRIZES.

For the Best design for Muslin Curtains, awarded to Miss Minnie Mahony, £4.
For the Second best design for do., awarded to Miss Marcella Irwin, £2.

NATIONAL AWARDS.

THE Examiners for National Competition have made the following Awards to the undermentioned Students of the Royal Dublin Society's School of Art.

Name.	Stage.	Description of Work.	Award.
Brett, Frances, .	23c	Design for Carpet, . . .	Silver Medal.
		Design for Muslin Curtains, .	Silver Medal.
Seymour, Frances,	14a	Flowers in Water Colour, .	Silver Medal.
Seymour, Kate, .	23c	Design for Muslins, . . .	Silver Medal.
Byrne, Edmond R.,	15a	Group in Oil, ...	Bronze Medal.
Irwin, Elizabeth, .	23c	Design for Muslin Curtains, .	Bronze Medal.
Seymour, Kate, .	17b	Head Painting from Life in Oil,	Bronze Medal.
Webb, Maria D.,	17b	Head from Life, and	Bronze Medal.
	15a	Group in Oil, ...	Bronze Medal.
Moss, Phebe Annie,	15a	Group in Oil, ...	Queen's Prize.
O'Brien, Kate, . .	19d	Model from Life, ...	Queen's Prize.
Plunket, The Hon. E.	23d	Design for a Wall Diaper, .	Queen's Prize.
Seymour, Kate, .	17b	Painting from Life in Oil, .	Queen's Prize.
	23c	Design for Wall Decoration,	Queen's Prize.
Smith, Robert S., .	19b	Model, Head of Apollo, .	Queen's Prize.
Wallace, Elizabeth,	23c	Design for Muslins, . . .	Queen's Prize.

PRIZE OF THE WORSHIPFUL COMPANY OF PLASTERERS OF LONDON.

The Hon. Miss E. M. Plunket, for Wall Diaper.

LIST *of Students whose Works were selected for National Competition*, 1870.

Names.	Selection.	Subject.
Byrne, Edmond R., . .	15a	Still Life from Nature in Oil Colours.
Brett, Frances, . . .	8b1 23c	Head from the Antique in Chalk, and Original Surface Design, Carpet and Muslins.
Garbois, Jane N., . .	8b1	Hand and Foot, shaded from the Antique in Chalk.
Gibson, Edward, . . .	19b	Model from the Antique (Dying Alexander).
Irwin, Marcella, . . .	23c	Original Surface Design (Carpet and Curtains).
Irwin, Elizabeth, . .	23c	Original Surface Design (Muslin Curtains), three Works.

Names.	Selection.	Subject.
Jordan, Frances Lydia, .	23c	Applied Surface Design (Wall Decoration).
	23d	Plastic Design (Tea Service).
M'Donnell, James, . .	14b	Landscape from Nature in Oil.
M'Gee, Mary A., . .	14a	Foliage painted from Nature in Water Colours.
	23c	Surface Design (Wall Decoration and Muslin Curtains).
M'Question, Harriett, .	8b1	Head from the Antique in Chalk (Julian de Medici).
Morgan, Marianne, . .	8b1	Head from the Antique in Chalk (Juno).
Mahony, Minnie, . .	23c	Applied Surface Design (Lace).
M'Gloyne, Bridget, . .	23c	Applied Surface Design (Muslin Curtains).
O'Brien, Kate, . . .	19b	Study in Clay from the Antique of Milo Venus.
	19d	Study in Clay from the Life, of Girl.
Perry, William, . . .	17b	Head of Female painted from the Life in Oil.
Poole, Olivia, . . .	9a	Anatomical Study of Human Figure.
Plunket, Hon. E., . .	23d	Original Plastic Design (Wall Diaper).
Reilly, Sylvester, . .	23b	Architectural Design (Parish Church).
	23d	Surface Design (Muslin Curtains and Wall Diaper).
Smith, Robert S., . .	19b	Modelling the Human Figure from the Antique (Head of Apollo).
	19d	Modelling the Human Figure from Nature (Bust from Life, of Boy).
Scott, Thomas, . . .	23d	Plastic Design (Wall Diaper and Mirror Frame).
Seymour, Kate, . . .	17b	Painting the Human Figure from Nature in Oil (Female Head), 2 Works.
	23c	Original Surface Design (Muslins and Wall Decoration, 2 Works).
Seymour, Frances, . .	14a	Painting Flowers from Nature in Water Colours.
	23d	Original Plastic Design (Wall Diaper).
Webb, Maria D., . .	14b	Landscape from Nature in Oil Colours.
	17b	Head painted from the Life in Oil.
	15a	Group painted from Nature in Oil Colours.
Wallace, Elizabeth, . .	14a	Flowers painted from Nature in Water Colours.
	23c	Original applied Surface Designs (Muslins).
Moss, Phebe Annie, .	15a	Still Life, painted in Oil Colours from Nature.
Smith, Stephen Catterson, ...	17b	Painting the Living Model.

LIST *of Students to whose Works Prizes have been awarded in the Competition of the Third or Highest Grade.*

Name.	Prize.	Stage.	Subject.
Byrne, Edmond Ripton, .	P 2	15*a*	Group of Rustic objects in Oil Colour.
Brett, Frances, . . .	P 2	23*c*, 8*b* 1	Original Design (Muslin Curtains), and Head of Barbarian Captive (Antique) in Chalk.
Baker, Leslie, ...	P 1	2*b*	Trajan Frieze, enlarged in Outline.
Dowling, R., ...	P 2	5*a*	Models shaded in India Ink.
Garbois, Jane, . . .	P 2	8*b*1	Hands and Feet in Chalk (Antique).
Gibson, Edward, . .	P 2	19*b*	Model of Dying Alexander.
Hall, Henry, ...	P 2	23*a*	Drawing of Machinery from actual Measurement.
Irwin, Marcella, . . .	P 2	23*c*	Original Design for Muslin Curtains.
Irwin, Elizabeth, . . .	P 2	23*c*	Original Design for Kidderminster Carpet.
Jordan, Frances Lydia, .	P 2	23*c*	Original Design for Wall Decoration.
Johnston, J., ...	P 2	5*a*	Models shaded from the Round in India Ink.
Magee, M. A., ...	P 1	2*b*	Tarsia in Outline, enlarged.
Morgan, Marianne, . .	P 2	8*b*1	Bust of Juno, shaded in Chalk from the Antique.
Moss, Phebe Annie, . .	P 2	15*a*	Group painted in Oil Colour from Nature.
M'Donnell, James, . .	P 2	14*b*	Landscape of Irish Scenery, painted from Nature in Oil Colour.
M'Question, Harriett, .	P 2	8*b*1	Head of Julian de Medici, shaded in Chalk from the Round.
M'Gee, Mary Anne, . .	P 2	23*c*	Original Design for Wall Decoration.
M'Grath, Emily, . .	P 2	8*b*1	Hand shaded from the Round in Chalk.
M'Gloyne, Bridget, . .	P 2	8*c*	Applied Surface Design (Muslin Curtains).
O'Brien, Kate, . . .	P 2	19*d*	Model in Clay of a Head from the Life.
Naylor, Elizabeth, . .	P 1	2*b*	Tarsia enlarged from the Flat in Outline.
Poole, Olivia, ...	P 2	9*a*	Anatomical Studies of the Human Skeleton.
Reilly, Sylvester, . . .	P 2	23c	Applied Surface Design (Muslin Curtain).
Smith, Robert Sidney, .	P 2	19*d*	Study of a Head from Nature in Clay (low relief).
Scott, Thomas, . . .	P 2	23*d*	Original Design for a Mirror Frame.
Seymour, Kate, . . .	P 2	17*b*	Female Head painted from Nature in Oil Colours.
Seymour, Frances, . .	P 2	5*a*, 14*a*	{ Group of Models shaded from the Round in Chalk. Flowers painted from Nature in Water Colours.
Webb, Maria D., . .	P 2	17*b*	Study of a Female Head from Nature in Oil Colours.
Wallace, Elizabeth, . .	P 2	14*a*	Flowers painted from Nature in Water Colours.

P 2, signifies Highest Prize; and P 1, Second Prize.

SECOND GRADE EXAMINATION, 10TH AND 11TH MARCH, 1870.

List of Students who have been successful.

Name.	Nature of Examination.				Prize Selected.
	Free-hand.	Geo-metry.	Per-spective	Model.	
Adams, Walter A., . .	E	E	E	P	Instruments and full Certificate.
Bagot, Amy, . . .	..	..	E		Sepia Landscape and full Certificate.
Beardwood, Joseph H.,	P	E	E	E	Colours and full Certificate.
Boucher, Dudley W., .	..	E	P	..	Burchett's Perspective.
Boucher, J., ...	..	E	..	..	Stanley on Instruments.
Byrne, Matthew, . .	E		..	..	Burchett's Geometry and Perspective.
Carson, Josephine E., .	..		..	E	Colours.
Comerford, Wm., . .	E	E	..	..	Instruments.
Corbett, Philip, . . .	..	E	..	P	Stanley on Instruments.
Douglas, Gertrude, . .	..	E	..	..	Puckett's Sciography.
Elliott, Mary A., . .	E	..	..	P	Colours.
Elliott, Zoe, ...	E	..	..	P	Colours.
Finigan, Thomas, . .		E	..	..	Instruments.
Fitzpatrick, Katie E., .	..	E	..	..	Burchett's Perspective, and full Certificate.
Flavelle, Julie, . . .	E	E	..	..	Instruments.
Freeman, Anna M., . .	P	E	..	..	Burchett's Perspective.
Grace, Philip J., . .	..	E	P	..	Burchett's Perspective.
Griffin, George, . . .	E	P	P	..	Instruments.
Jebb, Eglantyne, . .	E	..	P	P	Wornum's Ornament, and Lindley's Botany
Keating, Henry, . .	P	E	..	P	Puckett's Sciography.
Lawles, Louis, . . .	P	E	..	..	Burchett's Perspective.
Lee, Alice E., . . .	E	..	..	..	Colours.
Leybourn, Rev. John, .	E	..	..	P	Instruments.
Leonard, John, . . .	..	..	E	..	Colours.
Lynham, Nannie, . .	..	..	E	..	Sepia Landscapes.
MacManus, James C. .	E	..	..	..	Instruments.
Maffett, Isabella, . .	..	..	E	..	Colours and full Certificate.
Mark, Mathew W., . .	E	..	..	P	Colours.
M'Donnell, John, . .	E	P	E	E	Wornum's Ornament, Lindley's Botany, full Certificate.
M'Question, Harriette, .	P	..	E	..	Instruments.
Millard, Joseph, . . .	..	E	P	..	Burchett's Perspective and full Certificate.
Mitchinson, Caroline M.,	..	P	E	..	Burchett's Geometry and Perspective.

P. signifies *Pass*; and E. implies *Excellent*. A Student obtaining the latter mark is entitled to a Prize.

Name.	Nature of Examination.				Prize Selected.
	Free-hand.	Geometry.	Perspective	Model.	
Moss, William H., . .	..	E	P	..	Burchett's Perspective.
Murphy, Mary F., . .	..	E	..	..	Burchett's Perspective.
Nesbett, Francis M., .	..	P	E	..	Instruments.
Nolan, John F., . . .	P	E	..	..	Burchett's Perspective.
Norton, Kate, . . .	E	..	..	..	Instruments.
O'Nial, Elizabeth C., .	..	E	..	..	Puckett's Sciography.
Oldham, Eldreid, . .	.	P	E	..	Instruments.
Osborne, William, . .	E	..	P	..	Colours.
Plunkett, Hon. Miss E.M.	E	..	E	P	Instruments.
Rooke, John James, . .	P	..	..	E	Instruments.
Scott, Anthony, . . .	P	E	..	P	Burchett's Perspective and full Certificate.
Scott, John Miller, . .	P	E	.	..	Burchett's Geometry.
Seadon, Walter, . . .	E	..	..	E	Instruments.
Symes, Penella C., . .	E	..	..	..	Instruments.
Tobias, John D., . .	..	..	..	E	Instruments.
Webb, John, ...	..	..	E	..	Instruments and full Certificate.
Whelan, John P., . .	..	E	E	..	Burchett's Geometry and Perspective.
Williams, Oliver, . .	..	P	E	P	Sepia Landscapes and full Certificate.
Withers, George W., .	E	E	E	..	Colours.
Young, William, . .	P	..	E	P	Burchett's Geometry and Perspective; full Certificate.
Carr, Eleanor, . . .	P	P	P	P	Full Certificate.
Spencer, Arabella, . .	..	..	..	P.	Full Certificate.
Alexander, Mary E., .	..	P	..	..	
Baker, Leslie, . .	..	P	..	P	
Beardwood, John, . .	..	..	P	..	
Bradley, Dora, . . .	P	..	..	..	
Brown, Mary, . . .	P	..	..	..	
Carr, Annie H., . . .	P	..	..	..	
Cellem, Mary A., . .	P	..	..	..	
Dommett, Gordon, . .	P	..	..	..	
Dillon, Patrick, . . .	P	..	..	..	
Dundas, Olivia, . .	P	..	P		
Freeman, John K., . .	P	..	..	..	
Fuller, Elizabeth M., .	..	..	..	P	
Garbois, Jane N., . .	..	..	..	P	
Holahan, John, . . .	..	P	..	..	
Hutchinson, Caroline, .	P	..	..	.	
Johnson, John P., . .	P	..	..		

P. signifies *Pass;* and E. implies *Excellent.* A Student obtaining the latter mark is entitled to a Prize.

Name.	Nature of Examination.				Prize Selected.
	Free-hand.	Geometry.	Perspective	Model.	
Jordan, Francis L., . .	P	. .	. .	. .	
Kirkwood, Margaret, .	. .	P	. .	. .	
Leeper, William C., . .	P	. .	. .	. .	
Lynch, Thomas J., . .	P	. .	. .	. .	
Mackie, William, . .	P	. .	. .	. .	
Magee, Mary Anne,. .	. .	. .	. .	P	
Marks, James C., . .	P	. .	. .	. .	
Middleton, John, . .	. .	P	. .	. .	
Mies, John T., . . .	P	. .	. .	P	
Mitchinson, Elizabeth, .	P	. .	P	. .	
Mitchinson, Isabella, .	. .	P	P	. .	
Montgomery, M. L., .	P	. .	.	P	
Murphy, Hull J., . .	. .	. .	. .	P	
Murphy, Louis, . . .	P	. .	. .	. .	
Naylor, Elizabeth, . .	P	. .	. .	P	
O'Hanlon, Amelia, . .	. .	P	. .	. .	
Overend, Henry B. L.,. .	P	. .	. .	. .	
Robinson, Emily H., .	. .	P	. .	. .	
Ross, Bessie M., . . .	P	.	. .	. .	
Scott, Thomas, . . .	. .	P	. .	P	
Seadon, Thomas, . .	P	. .	. .	. .	
Seadon, William, . .	. .	P	. .	. .	
Smith, Joseph C., . .	P	. .	. .	. .	
Stuart, Walter C., . .	P	. .	.	. .	
Thornhill, Harriette, .	P	. .	. .	. .	
Todd, Dora H., . . .	. .	. .	P	. .	
White, John R., . .	P	. .	. .	. .	
Whitthorn, Joseph, . .	. .	. .	P	. .	
Yates, Maude A., . .	P	. .	. .	. .	

(Signed) EDWIN LYNE,
Head Master.

P. signifies *Pass;* and E. implies *Excellent.* A Student obtaining the latter mark is entitled to a Prize.

List of Loans made by the Department of Science and Art to the Society's School of Art.

Two Original Life Studies, by Mulready.
Four Water-Colour Drawings, viz.:—
The Belated Traveller, by David Cox.
Street Scene in Vitré, France. C. C. Pyne.
Scene in North Wales. J. Kemp.
Flowers from Nature, in Tempora.

Milton Shield (electrotype reproduction).
Nine Fan Designs (French) purchased in the Universal Exhibition of Paris, 1867, retained one week.
Photographs of Decorative Plate, 1 vol.
  Do. of Indian Architecture. 1 vol.
  Do. of Treasures of Pretrossa. 1 vol.
  Do. of Holbine's Designs. 1 vol.
National Portrait Catalogue. 3 vols.
Catalogue of Reproductions. 1 vol.
Hand Book of Engravers of Ornament.
Report on Paris Exhibition. 5 vols., 2 sets.
Index of do., 2 vols.
Catalogue of British Section of Paris Exhibition. 2 vols.
Illustrations of the Genius of Michael Angelo.
Universal Catalogue of Books on Arts. 1 vol.
Chromolithographs of the principal objects of Art in the South Kensington Museum. Part 3.
Cloisters of Monreale, Sicily (Photographs). 1 vol.
Italian Sculpture of the Middle Ages (Photo.). 1 vol.
Corporation and College Plate (Photo.). 1 vol.
Universal Catalogue of Books on Art. Vol. 2nd.
Illustrations of Ancient Buildings in Kashmeer (Photo.). 1 vol.
Waring's Stone Ornaments (Monuments of). 1 vol.
Etchings of Art Objects, 5 series. 1 vol.
Italian Ruins (Canaletto), Oil.
Study of Male Head (Etty), Oil.
Distant View of Windsor (Water-colour). D. Cox.
Hydrangea (Water-colour). E. Jackson.
Nine Fan Designs, Modern French, purchased in the Universal Paris Exhibition of 1867, and executed by the following Artists, viz.:—A. Pascatti, E. de Beaumont, Croun, Henri Picou, E. Froment, Mme. Callamatta, retained for four weeks.
Catalogue of the Loan Exhibition of Fans.
One Male Life Study by Mulready.

TABLES *showing the Progress made by the Royal Dublin Society's School of Art.*

Year.	Number of Students.		Amount paid.
			£ s. d.
1862	344	who paid	265 16 4
1863	348	,, ,,	279 15 9
1864	436	,, ,,	388 14 11
1865	484	,, ,,	416 0 0
1866	431	,, ,,	418 1 4
1867	432	,, ,,	458 5 10
1868	519	,, ,,	470 14 1
1869	538	,, ,,	510 9 6
1870	616	,, ,,	458 6 0

TABLE *showing the Number of Students of External Schools instructed in Drawing through the Agency of the Central School.*

Year.	Number of Students.
1862,	640
1863,	1348
1864,	1848
1865,	2485
1866,	——
1867,	about 3500

TABLE *showing the Result of Local Examination of Second Grade.*

Year.	Number of Students successful.	Number of Papers passed.
1861	20	22
1862	32	45
1863	23	30
1864	42	63
1865	72	115
New arrangement and standard of excellence raised.		
1866	52	80
1867	67	98
1868	112	164
1869	105	151
1870	99	159

TABLE *showing Result of National Competition.*

Year.	Number of Awards.	
1857	2	Nat. Medallions.
1858	1	
1859	1	
1860	2	
1861	1	
1862	2	
1863	1	
1864	4	
1865	4*	
1866	8†	
1867	9	
1868	11	
1869	11	
1870 16 Awards to 13 Students, and represented by	13	

* Representing five awards.
† National awards, first given in 1866, consisting of Gold, Silver, and Bronze Medals and Queen's Prizes. The latter having the same value as the National Medallion previously given as the highest distinction.

Year.	Number of Local Medals.	Honorable Mention.
1863	13	2
1864	20*	5
1865	32†	–

Third, or highest Grade, Prizes, instituted in lieu of Local Medals in the Year 1866.

Year.	Number of Prizes.	Honorable Mention.
1866	14	8
1867	15	4
1868	16	1
1869	22	1
1870	31	–

The successful Students having been called up, received the Prizes awarded to them from His Excellency. At the conclusion of this ceremony,

The Marquis of Hartington, Chief Secretary for Ireland, rose and said—Your Excellency, my Lords, Ladies, and Gentlemen, I can assure you that it is with great pleasure I find myself for the first time in the position of addressing, in my official capacity, an Irish audience. Perhaps you will let me say that, like most Englishmen—although Irishmen are not very willing to acknowledge it—I have long felt a deep interest in and a deep sympathy with Ireland and the Irish people. If on this, the first occasion of my coming among you, I may be permitted to remind you, that although a great part of my life has been spent in England, I am connected by ties of relationship and property with this country, so that you will not receive me quite as a stranger among you; and you will also allow me to express a hope that whether my official connexion with you is destined to be long or short—whether it produce no better or more lasting results—it will at least leave behind it on both sides pleasant and agreeable recollections. I have heard with great satisfaction, from the able speech of Mr. Maunsell, and from the report of the Committee, statements which prove that in this country one at least—and I hope that it is not a single instance, but that there are many similar institutions—that one useful and meritorious institution has prospered during the year, and that the branch of education and culture to which it devotes itself has made in this city satisfactory progress. I am glad to find, although I am sure you will excuse me if, after making so very recent an acquaintance with Irish affairs, I show but little knowledge of the subject, that art and scientific education in this country has not been altogether neglected by the Government. I find that a short time ago a commission was appointed for the purpose of inquiring how far this and similar institutions for the purpose of promoting the cultivation of science and art would be most usefully combined and brought into harmony with each other, and, as far as my memory serves me, to inquire how the advantages intended to be held out to the whole country, by a grant given by Parliament for the promotion of education in science and art, would be most usefully extended. I do not know whether those who hear me concur generally or not in the recommendation made by that commission. I find that they did not recommend, as at one time contemplated, a Science and Art Department expressly for this country, because in their opinion the establishment of such an institution would not be for the benefit of Ireland, and that Ireland would derive greater benefit from the advantages held out by the general Science and Art Department of London. I find they made many recommendations by which these advantages might be extended. I have not had an opportunity of learning how far they have been carried out, but I am quite sure my

* Half a year's work.
† Being two Medals in excess of the maximum number allowed by rule.

noble friend the Lord Lieutenant and the Government will only be too happy to fully consider these suggestions, in so far as they have not been carried out, and that we will do all in our power to extend to Ireland those advantages which have been pointed out by Mr. Maunsell as having been reaped by England and Scotland. I will not trespass on your time this evening. I will only say that, although I have not hitherto turned my attention to the subject, in my opinion it is almost impossible to overrate the advantages conferred on a country in the extension to all classes of education in science and art. It has been pointed out, partly on this and partly on other occasions, that the material advantages of such an education is very great, and that thoroughly diffused art education adds greatly to the material value of the productions of a country; but I would beg of you to remember that however great those benefits, the advantages to be derived by a country are not to be measured by any such material results. I believe that by the spread of art education you will be doing much to give a new pleasure, a new taste, and a new source of enjoyment to hundreds of your fellow-countrymen—advantages that cannot be measured by any calculation of pounds, shillings, and pence. I am glad to know that you have made and are making satisfactory progress in the matter. I can only say that so far as the Government and myself are concerned, we will be always willing to do what lies in our power to further you in the good work, and I hope the results in future will be as satisfactory as they appear to have been in the past. I have to thank you for the kind reception you have given me on this my first appearance among you.

Lord Clonbrock, as one of the Vice-Presidents of the Society, said it became his pleasing duty to return thanks to His Excellency for the kind manner in which he had responded to the invitation of the Society to honour them with his presence. Of all the liberal objects which commanded the attention of the Royal Dublin Society, he did not know that there was one more useful—certainly there was none more interesting—than that which had been the means of bringing the present assembly together. He regarded the institution of these Schools of Science and Art as a wise and salutary measure. It was well known that in the middle classes of society, but especially among the artisan class, there was a considerable amount of talent and genius lying dormant, and needed only to be drawn out by education to be utilised. However widely genius might exist in a country, unless it were developed by education, it would be of little value. With respect to the Royal Dublin Society's Schools of Art, there was much in the report which had been read to make them look back with satisfaction to the past, and forward with hopes to the future. He believed there was much in the disposition of the people of this country to make these schools highly popular, and that there was a quickness of apprehension and of imagination in his countrymen that should make them very favourable recipients of instruction in art which these schools imparted. He found that since the year 1862 the number of pupils had nearly doubled, showing the increased popularity of the school, and he also found that in a comparison of five of the most distinguished schools of a similar kind in England with this country, the Irish school stood first. He thought in those figures there was great encouragement for the Society generally, and more especially to Colonel Adamson and his committee to continue those labours which they had hitherto so successfully prosecuted. To develope the talent which so largely existed in the country, to present the means of an art education to those classes which were unable to procure it for themselves, is a noble and patriotic task, and one well worthy to be undertaken by this ancient and honourable Society. In this task, as in others to which the Society devotes its attention, it has felt itself much encouraged and assisted by the kind interest which His Excellency has ever taken in its proceedings. For this kind interest and the patronage which His Excellency has uniformly extended to it, he (Lord Clonbrock) was commissioned to tender to His Excellency the Society's most grateful thanks, as well as for the distinguished honour of his presence here this evening.

His Excellency Earl Spencer, who was received with applause, addressed the assembly. He said,—My Lords, Ladies, and Gentlemen, it is one of the most pleasing of my duties, as the humble representative of Her Majesty, to attend on occasions like the present. I know that in coming here I am fulfilling the wishes of Her Majesty, whose love for art and science has so often been shown, and whose own family numbers some distinguished artists, and I am representing, therefore, one of the objects which she most has at heart when I attend in Ireland at a meeting of this kind. I feel, I confess, some difficulty in repeating for a third time a visit to this room on this special occasion, for I know I can say little that is new or little that is interesting; in this respect I have to beg your indulgence. But I can at the same time speak with more certainty than I did on previous occasions of the good which I know this Society does in Ireland with regard to the promotion of art and science, for I am able to watch the progress which this school has made; and I am glad to see from the report, and to hear from the speeches which have been made to-night, that there has been a steady and constant improvement in the Art School of the Dublin Society. I need not refer to the figures relating to that matter. They have been most minutely and elaborately gone into by Mr. Maunsell. The increase this year alone is sufficient to show how greatly the advantages of this school have been used by the people of this city, for I see that 59 more students have attended the school during the past year as compared with 1859. I find that in national competitions, which is the highest test that can be given to any school of this sort, more prizes have been awarded to the pupils of the Royal Dublin Society's School of Art than in any former year or to any other school. Out of thirteen awards that have been given this year, I ought to mention the name of one lady who has succeeded in obtaining four, and has thus added considerably to the honour of the school. I regret she is not here to-night. I allude to Miss Kate Seymour. These results must be encouraging to those who have at great pains supported the school. It shows that they have been right in supposing that the Irish people have an aptitude for the pursuit of art, science, and good taste. It is natural to suppose that this would be the case from the intelligence and imagination of the Irish people; and it must be gratifying to those who have supported this school to see that their efforts have been crowned with success. I see by the report a further proof of the success of this school in the fact that in England and Scotland several large manufacturers have purchased designs that have been made by the pupils here. I myself had the pleasure of seeing the other day some works that have been ordered by an enterprising merchant in this city. I saw some carpets that have been made after the designs by one of the successful competitors of last year; and I see that the citizens of Dublin have given proof of their appreciation of the value of improvements in taste and manufactures by offering prizes for designs to the United Kingdom. This I think is eminently satisfactory, and particularly as we know that in some respects Dublin labours under disadvantages. To one of these disadvantages Mr. Maunsell and others have alluded; the want of a museum for ornamental art in this city. I most sincerely wish we could see one established here. I am glad to find the Royal Dublin Society turning their attention to this matter, and I assure you that I shall be most happy—and I know I can say the same of my noble friend beside me—to discuss and consider any proposition which they may have in view to further the design of establishing such a museum in this city. I know full well that without such a museum it is almost impossible to instruct pupils, or to stimulate a love of art amongst the people of the country. While alluding to this subject I cannot pass over some gains that have been made during the last two years with respect to art in Dublin. The Royal Irish Academy I believe have made considerable improvements to enable the public to see their magnificent collection of ancient works of art—works I believe that are unrivalled in England or Scotland. To the National Gallery some very important works of the ancient masters have been added, and a loan collection is there of the same nature, which ought to have an important influence on art in this country. I must allude also to an attempt

recently made—unfortunately without success, though I trust there will be better fortune on a future occasion—an attempt to get together a collection of portraits connected with Irish history. A few years ago in London a similar exhibition was held with much advantage to the public; in that exhibition were a considerable number of Irish portraits; but I am satisfied that a great many more portraits would be obtained in the Irish capital if a collection was established there. Gentlemen who own valuable and interesting portraits in this country, while reluctant to send them across, I will not say the "melancholy ocean," as did Mr. Maunsell, for England is only separated from us by a channel, but across the Channel, and to run the risk of transmitting them to London, would be quite happy to contribute them to an exhibition in Dublin. There can be no doubt that apart from the interest which such an exhibition would create, much profit to art would be derived from it, as many works of high artistic merit would be brought before the public. A portrait gallery in Dublin would be a neutral ground of history where no dissensions—none of those religious or other dissensions which, unfortunately, too often prevail in Ireland—could in any way interfere; and I most sincerely hope that we may be able at some future time to promote an exhibition of this nature in the Irish metropolis. It depends, however, greatly on the support given to the project by the owners of works of art and the public generally. If it could be shown that a good and useful exhibition of that sort could be got up in Dublin, there would be a strong case to ask for aid for it from the Government, and I should be very glad to support the application. I will not detain you further to-night; I will merely congratulate the successful competitors, and express a hope that the taste and skill which they have shown in art, and which has received its fitting reward this night, may be successfully developed, not only for their advantage but to the honour of the school in which they first received their instruction—the Art School of the Royal Dublin Society.

The proceedings then terminated.

EVENING SCIENTIFIC MEETINGS.

MONDAY EVENING, NOVEMBER 21, 1870.

HUMPHRY MINCHIN, M. D., in the Chair.

Mr. W. F. KIRBY, Assistant in the Museum of Natural History, read a paper "On the *Sphingidæ*," in the Museum of Natural History.

In reply to an objection by Mr. Adair, relative to the periodical abundance or scarcity of certain insects, Mr. KIRBY said that various causes had been suggested to account for the occasional comparative abundance of certain insects. The causes were probably temporary, such as the scarcity of some species of bird which preyed on a particular insect, or the occurrence of an unusually favourable season for allowing a larger number of larvæ to mature. The Humming-bird Moth was very conspicuous on the wing, and as it flew by day as well as at dusk, and was a garden insect, its appearance in fine summers usually attracted much attention.

Mr. MORE remarked on the habits of the Humming-bird Hawk Moth flying along bare walls, as he had observed near Glasnevin.

Mr. HOWARD GRUBB, C. E., read a paper, "Descriptive of the New Automatic Spectroscope," constructed by him for the Society.

A large number of Insects from the Museum, as well as other objects of interest, were exhibited.

MONDAY EVENING, DECEMBER 19, 1870.

ROBERT STAWELL BALL, A. M., in the Chair.

G. JOHNSTONE STONEY, A. M., F. R. S., delivered "A Discourse on Recent Discoveries in Molecular Physics."

MONDAY EVENING, JANUARY 16, 1871.

G. JOHNSTONE STONEY, A. M., F. R. S., in the Chair.

Mr. HERCULES ELLIS read his paper "On the Seasons of the Gnat Year."

Mr. GEOGHEGAN, Architect, read a paper "On a New Method of Extending existing Bridges and reducing steep Gradients, with special reference to remodelling Carlisle Bridge, Dublin."

MONDAY EVENING, FEBRUARY 20, 1871.

CROKER KING, M. D., in the Chair.

Dr. ALEXANDER MACALISTER delivered "A Discourse on recent Advances in Comparative Anatomy."

MONDAY, MARCH 20, 1871.

ROBERT S. BALL, A. M., in the Chair.

RAMSAY H. TRAQUAIR, M. D., read his communication "On the Restoration of the Tail of the African Mud Fish (*Protopterus annutens*)," illustrated by a specimen in the Society's Museum.

David Moore, Ph. D., Director of the Botanic Garden, read his paper "On a Fungoid Disease which attacks and destroys Plants belonging to the natural order Pandaneæ or Screw Pines."

After some observations by Mr. Adair, Mr. Kirby, and Dr. Steele,

Dr. Moore said that Dr. Wright had observed young plants similarly affected in the tropics. The *Pandanus* referred to certainly did not die of old age, as it had never yet flowered, and he had always expected that it would do so. It was probably the oldest specimen in Europe. One was known to flower last year at the Botanical Gardens in Edinburgh. A *Pandanus* in Ceylon (*P. odoratiferus*) perfumes the whole forest for a mile round where it flowers; but only very old trees flower.

Professor Dyer read his paper "On the Germination of Seeds;" in which it was demonstrated that the germination of certain monocotyledonous seeds was not endorhizal.

Dr. Steele remarked on the importance of the subject, and the necessity for a more extended series of observations.

Mr. Kirby read "Notes on Three Species of Trap-door Spiders, whose nests are in the Museum of the Royal Dublin Society."

Monday, April 3, 1871.

Professor R. S. Ball, A. M., in the Chair.

Mr. James Dillon, C. E., read a paper "On the Defects of the Irish Railway System, and the best way of facilitating the construction of cheap Branch Railways," in which he advocated the adoption of a very narrow gauge for branch railways with little traffic.

Mons. Henri Charlier's paper "On an Improved System of Horse Shoeing" was read by Dr. Tuffnell.

Mr. J. Haughton said that he had been much struck with a new system of horse shoeing, invented by Mr. James M'Kenny, and published in the *Weekly Freeman*. A small lump of gutta-percha, fastened between two plates of copper, was slipped in under the shoe when the horse was shod, so as to enable the horse to rest on the frog. This system, which was very simple, and required very little alteration in the old system of shoeing, was adopted by two veterinary surgeons and horse shoers in Dublin.

Dr. Stewart said that Lord James Butler has tried both Mr. M'Kenny's system and M. Charlier's, and found the latter much preferable, producing a feeling of perfect safety in both horse and rider. If a horse was shod on M. Charlier's system, the sole of the foot soon becomes perfectly hard.

Mr. Francis, of Camden-street, said that if the frog was not trimmed, it was liable to split at the point and exfoliate. He asked if it was liable to do so in M. Charlier's system, and if the wall of the foot would bear the weight of horse and rider. As the frog grows, it requires trimming, and he thought a medium should be observed.

Mr. John Gloag, of the Royal Irish Constabulary, said that he had tried M. Charlier's system on twenty-five horses, with sound feet, and found it to answer remarkably well. He could not say if it would be equally serviceable for horses with flat feet or weak crusts. The foot exfoliates, and casts off as much as is necessary, and does not require cutting. The frog completely changes its character, and becomes firm and elastic. The sole becomes stronger by attrition, and a defence to the interior foot.

The Chairman asked Dr. Tuffnell what was the expense of shoeing horses on M. Charlier's system?

Dr. Tuffnell said that the shoes could be altered to suit different feet. When a horse is shod on M. Charlier's system, his feet work better, and he feels more confidence, and can carry a heavier weight. The shoes cost 5*s.*, instead of

4*s*., but they last longer. The material he first used was broken coach springs; but a proper material, a combination of steel and iron, had now been introduced. He had three horses shod on M. Charlier's system, from 18 months to 3 years ago. Where the horny part of the foot would have been cut away on the old system, buttresses of horn had been thrown out. The frog becomes as elastic as india-rubber, with buttresses of horn on both sides, and the sole of the foot becomes as hard as stone.

Mr. G. W. Maunsell asked if M. Charlier's shoe was applicable for every variety of work? When horses' feet are weak, farriers recommend a leather shoe to be used for their protection. He thought that the new system might answer for ploughing, but it was not applicable to horses worked at high speed. A newly-shod colt cannot work until he has tried his paces.

Another Gentleman said that the shoes employed for racers hardly differed from M. Charlier's.

Dr. Tuffnell said that when the horse's foot had not been pared, there was no necessity to use a leather sole; but this might perhaps be the best system for very weak feet. He asked Mr. Noone to speak of his experience of M. Charlier's shoe for hunters.

Mr. Peter Noone said that he had tried M. Charlier's shoe for three years, and that there was no better shoe for hunters.

Another Gentleman said that steel of proper quality for M. Charlier's shoes could be obtained, at a fair price, as soft and more durable than any iron. Steel and iron will not weld together, and are scarcely likely to answer.

Mr. Goode said that Mr. Henry Scrivan had tried M. Charlier's system for some years, and found it good for agricultural, carriage, and hunting horses. The system was introduced six or seven years ago, and had come into use very much during the last twelve months. He thought that it was the perfection of horse shoeing, and applicable to any foot. If the frog comes to the ground, the horse cannot slip. Some years ago a country blacksmith, in Mayo, used to shoe horses on a system somewhat analogous to M. Charlier's, and it answered admirably. Its only defect was that the shoe used was too thick, and prevented the frog from touching the ground—a difficulty entirely got over by M. Charlier. A horse shod on M. Charlier's system will not pick up a stone on any ground.

Monday Evening, April 17, 1871.

G. Johnstone Stoney, A. M., F. R. S., in the Chair.

Mr. Howard Grubb, C. E., delivered a discourse 'On the Spectroscope."

Monday Evening, May 22, 1871.

Prof. W. T. Thiselton Dyer, in the Chair.

Prof. Robert S. Ball described the principle of Kater's Pendulum. First, he explained the properties of the simple pendulum, and showed that a weight suspended at the end of a string 14 feet long, took the same time to oscillate in a long arc as in a short one. Galileo was the first to observe this, and he measured the time by counting his pulse during 100 oscillations of the pendulum. This discovery led to the invention of the clock. The time which a pendulum takes to oscillate does not depend either on the length of the arc, or the weight, or on the material of the weight. It is regulated by the force of gravity, and the length of the pendulum. One pendulum one-fourth the length of another makes four vibrations, while the longer one makes two. Therefore the time of the vibration of the pendulum varies as the square root of its length. If

gravity did not exist, the pendulum would not move at all; if its force were greater, the pendulum would move faster. If the length of the pendulum and the time of vibration be calculated, the force of gravity could be ascertained. To do this, the pendulum might be allowed to oscillate for twenty-four hours if necessary, and the number of seconds it took to perform its vibrations would then be divided by the number of vibrations. The exact length of the pendulum was very difficult to measure, for the exact point of suspension at the top, and the exact centre of the pendulum at the bottom, were not easy to ascertain. But Captain Kater had invented an instrument which evaded these difficulties. He suspended a bar from two knife-edges of steel at the top of the pendulum. This pendulum will vibrate for a very long time on account of the slight resistance presented. By comparing the vibrations of the simple pendulum with this, until they correspond, we get the length of the corresponding simple pendulum. The time of vibration of the rod is found to be equal to that of a pendulum of two-thirds its length. If another pair of knife-edges be attached to the rod at this point, the rod will swing in the same time if inverted. Therefore the centre of oscillation and the centre of vibration are reciprocal. When the knife-edges are properly adjusted, the distance between them equals the length of the corresponding simple pendulum.

Prof. BALL then exhibited Moore's Patent Pulley Block, which consists of a lifting chain round a pulley which works two other pulleys precisely equal in diameter, but turning in opposite directions, with a very slow but equal motion. If the lifting chain is pulled, it raises the other two. A stone weight easily lifts a hundredweight. If the lifting chain be pulled 31·6 feet, the weight is raised one foot; but on an average the lifting power of the machine is only 10·4, so that two-thirds of the work were consumed by friction. If more than half the work is thus absorbed, the pulley cannot overrun, and the weight remains suspended.

Prof. BALL also called attention to a very compact form of Hydraulic Press, which was on the table. It could exert a pressure of ten tons. The motion of the ram was very slow, the velocity ratio being about 500. It will shear iron half an inch square.

Dr. J. EMERSON REYNOLDS gave an account of Experiments on the Flow of Liquids through capillary tubes, and said that he had been much interested in reading of some old experiments made by M. Poseuille on the flow of liquids through capillary tubes, and he had repeated and verified some of them. It is well known that liquids flow faster through broad tubes than through narrow ones; but M. Poseuille successfully sought for the laws regulating the efflux. In his experiments a globe was employed capable of holding six cubic centimetres, with a capillary tube at the lower extremity, and a tube connected with a vessel of compressed air at the top. The pressure was maintained practically constant throughout the experiment. It was found that when the length of the tube was doubled, the rapidity of the flow was diminished by half—that is to say, if the tube was an inch in length, and the globe took 500 seconds to empty itself through it, it would require 1000 seconds if the tube was two inches long. When two tubes of equal length were contrasted, the rate of flow was found to be proportional to the fourth power of the diameter. Any rise in temperature increased the rapidity of the flow, and it was also much affected by the chemical composition of the liquid. In addition to water, solutions of various salts were experimented with. Some were found to accelerate the flow, and others to retard it. It was retarded by common salt, by the chlorides of various metals; it was increased by substances known in medicine as powerful diaphoretics, by nitre, iodide of potassium, nitrate, and chloride of ammonium, &c. Liquids holding uncrystallizable or albuminous matter in solution, flowed much more slowly. Mr. Graham, the late Master of the British Mint, had also investigated the matter. He found that the viscosity of a liquid did not accelerate or retard its flow, neither did its density or capillarity; but chemical composition greatly affected it. The transpiration time of alcohols in-

crease with their complexity of chemical composition. M. Graham also experimented with hydrates, and found that there was a great difference between crystalloids and colloids. It was very important to find a means of rapidly estimating the quantity of albumen in bodies, without having recourse to the long and tedious operations of a regular analysis. Dr. REYNOLDS pointed out that the transpiration time of a liquid might be used for this purpose, and exhibited a very simple arrangement by which the rate of flow of a given liquid can be ascertained. The apparatus consisted of a graduated tube, a metre in length, divided to deliver 100 cubic centimetres; to the lower part of a very fine thermometer tube, 50 m. m. long, is attached. The transpiration time of many liquids can be easily ascertained by noting with the watch the time required for the flow of 50 c. c. of a given length, 50 centimetres of water run out in the tube exhibited in five or six minutes; but if only one per cent. of albumen be added, the time is increased by nearly a minute and a quarter. The percentage of albumen can thus be determined by the time 50 c. c. of a solution of it takes to run off. The same method can be used to ascertain the amount of caseine in milk. Gum and sugar also increase the time by an amount proportional to the percentage of either body.

The CHAIRMAN remarked that this was an admirable instance of philosophical research proving of practical importance. What had been merely a series of recondite experiments with Mr. Graham, became a valuable instrument in the hands of Dr. Reynolds.

Mr. W. F. KIRBY then communicated a paper, entitled "List of Species of Papilioninæ, or Swallow-tailed Butterflies, in the collection of the Royal Dublin Society," and exhibited specimens in illustration.

Prof. BALL then took the Chair.

Prof. W. T. THISELTON DYER then made some remarks on Bud Scales. These were common on buds, but were generally shed when the leaves were fully expanded. When buds hybernate, they require some protection from the weather. The scales of the sycamore are modifications of the petiole or stalk. In the beech they are stipulatory organs, which overlap and cover the small leaves. When the leaves expand, they begin to wither, and fall. These scales are found in lime, sycamore, beech, wyth elm, &c., representatives of three widely-separated orders. In the horse-chestnut you sometimes find a specimen which is partly bud-scale and partly leaf. This proves that the scales are stipules. No petioles are present. The same conditions in widely different plants are met by similar arrangements. In illustration, he exhibited a composite plant from South America, which resembled in its foliage a Lathyrus from the south of England. Butterflies were supposed to derive some advantage from mimicry, and mimicking species always came from the same locality; but it was not the case with plants, for plants that resembled species of another group nearly always occurred in widely separated localities. Soil, climate, and the struggle for existence seem to be the cause of plants sometimes resembling other groups.

The CHAIRMAN said that mimicry might be useful to a plant, and instanced the case of a species of Lathyrus, which closely resembles grass. The Yellow Goat's beard, too, resembles the usual foliage in places where it grows.

Prof. DYER remarked that mimicking plants mostly occur in different parts of the world, and that cases like that mentioned of the Lathyrus resembling the grass amongst which it grows are comparatively rare.

Mr. A. G. MORE then exhibited some rare Animals and Birds which had recently been added to the Society's collection.

A specimen of the American Goshawk had been presented by Mr. Massey Dawson, whose brother, Captain Massey, shot it at Ballinacourtè. It had been killed twice in Ireland, and once in Scotland, and was supposed to have flown across the Atlantic. Two species of Wild Swans were on the table, along with the young of one species, and of the tame Swan.

The Mammals exhibited were as follows:—1. A species of Lemur from Madagascar. The Lemurs are closely related to the monkeys, and are peculiar to Madagascar; they are soft, woolly-coated animals, are nocturnal in their habits, and feed on roots and fruit. 2. Empleres, a kind of civet, which burrows in the sandy plains, and is nocturnal in its habits. 3. Cuscus, a marsupial animal, from Malacca, closely related to the American opossums; it is nocturnal, and lives on fruits; its tale is prehensile. 4. Nilurus, called in India the Red Cat Bear; lives in trees, and eats vegetables, fruit, eggs, &c. 5. The Leopard Cat, from India, lives in trees, and feeds on birds; it is very wild and savage. 6. Erethiza, or Ourson, a North American animal, closely related to the crocodiles; it lives in thickets, and eats the bark of trees; the short spines are used by the Indians for needles; it is very good to eat.

Finally, Mr. Morse exhibited the Monitor Lizard, which lives in the rivers of Africa, and was supposed to warn travellers of the vicinity of crocodiles by whistling.

APPENDIX.

METEOROLOGICAL JOURNAL,

KEPT AT

The Royal Dublin Society's Botanic Garden, Glasnevin,

[HEIGHT ABOVE LEVEL OF SEA, 65 FEET,]

FROM

1st APRIL, 1870, to 1st MAY, 1871.

APRIL, 1870.

DATE. Day, At 12 o'Clock, P. M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
			°		°	°	°	°	°	°	°				
1 Friday, . . .	●	30·064	52	30·100	54	42	36	43	46	54	53	N. E.	3	·040	Showery.
2 Saturday, . .	1	30·336	52	30·872	52	35	30	44	46	53	51	N. E.	4	·320	Showery.
3 Sunday, . .	2	30·380	53	30·344	55	30	26	48	45	55	53	N. E.	6	. .	Fine, breezy, bright sunshine day.
4 Monday, . .	3	30·400	56	30·326	58	32	28	44	45	58	56	N. E.	6	. .	Do.
5 Tuesday, . .	4	30·216	54	30·148	58	31	26	43	45	58	56	S. W.	6	. .	Do.
6 Wednesday, .	5	30·030	54	29·962	57	34	27	43	45	56	54	S. W.	4	. .	Breezy, changeable, occasional sunshine.
7 Thursday, . .	6	29·886	56	29·813	60	43	36	45	46	60	56	S. W.	3	. .	Do.
8 Friday, . . .	7	29·424	54	29·358	56	44	37	45	46	56	54	S. W.	3	. .	Do.
9 Saturday, .	8	29·350	55	29·310	49	38	30	43	45	49	47	N. E.	2	·400	Breezy, wet, occasional sunshine.
10 Sunday, . .	9	29·840	50	29·783	52	36	31	42	44	52	50	S. W.	4	. .	Breezy, changeable, occasional sunshine.
11 Monday, . .	10	30·030	52	29·967	54	43	37	43	45	53	51	S. W.	2	. .	Do.
12 Tuesday, . .	11	29·912	51	29·855	58	46	40	44	46	52	50	S. W.	0	. .	Breezy, cloudy, rain-like day.
13 Wednesday, .	12	30·076	52	30·013	53	50	45	46	47	52	50	S. E.	0	·150	Cloudy, mild, wet day.
14 Thursday, . .	13	30·320	52	30·257	54	41	36	45	47	54	51	N. E.	2	·150	Breezy, changeable, occasional sunshine.
15 Friday, . . .	14	30·400	51	30·342	55	40	34	47	48	55	52	N. E.	2	. .	Do.
16 Saturday, . .	15	30·450	54	30·382	56	41	36	46	48	55	53	S. E.	4	. .	Foggy, changeable, occasional sunshine.
17 Sunday, . . .	16	30·292	58	30·213	61	37	33	47	48	61	57	S. E.	6	. .	Fine, mild, bright sunshine day.
18 Monday, . .	17	30·040	59	29·961	63	37	32	47	49	63	60	S. E.	6	. .	Fine, breezy, bright sunshine day.
19 Tuesday, . .	18	29·850	56	29·777	57	42	39	47	49	57	55	S. E.	6	. .	Do.
20 Wednesday, .	19	29·775	54	29·705	57	42	39	48	49	56	55	S. E.	0	. .	Breezy, cloudy, rain-like day.
21 Thursday, . .	20	29 950	56	29·877	57	38	33	46	48	56	54	S. E.	5	·020	Breezy, light showers, occasional sunshine.
22 Friday, . . .	21	29 950	55	29·875	56	46	40	48	49	56	54	S. E.	4	·040	Do.
23 Saturday, . .	22	30 250	52	30·187	55	39	33	45	48	55	53	S. W.	5	·020	Do.
24 Sunday, . . .	23	30·258	54	30·190	56	46	39	46	48	56	54	S. W.	2	. .	Breezy, changeable, occasional sunshine.
25 Monday, . .	24	30·292	54	30·224	55	49	42	47	49	54	52	S. W.	0	. .	Breezy, cloudy, changeable day.
26 Tuesday, . .	25	30·060	51	30·002	54	48	40	47	49	53	50	S. W.	1	·030	Breezy, showery, occasional sunshine.
27 Wednesday, .	26	30·250	50	30·192	52	38	32	44	47	51	49	S. W.	2	. .	Breezy, changeable, occasional sunshine.
28 Thursday, . .	27	30·176	44	30·134	46	40	34	43	47	46	45	N. E.	0	. .	Breezy, cloudy, changeable day.
29 Friday, . . .	28	29·950	50	29·893	51	39	33	43	45	51	49	N. W.	0	. .	Do.
30 Saturday, . .	●	29·676	55	29·609	57	47	41	40	47	56	54	N. W.	1	. .	Breezy, changeable, occasional sunshine.
													82	1·170	inches.

MAY, 1870.

DATE. Day, At 12 o'Clock, P. M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In earth. 5 in.	THERMOMETER. In earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
			°		°	°	°	°	°	°	°				
1 Sunday, . . .	1	29·578	51	29·521	53	41	35	45	47	53	51	N. W.	3	·040	Breezy, occasional sunsh., light showers.
2 Monday, . . .	2	29·972	44	29·931	47	36	29	43	45	47	46	N. W.	2	. .	Breezy, changeable, occasional sunshine.
3 Tuesday, . . .	3	30·080	49	30·028	52	41	34	43	45	51	48	N. W.	3	. .	Do.
4 Wednesday, . .	4	30·224	48	30·172	51	41	33	44	46	50	48	N. W.	0	. .	Breezy, cloudy, changeable day.
5 Thursday, . . .	5	30·298	49	30·246	52	42	35	45	47	51	49	N. W.	0	. .	Do.
6 Friday, ...	6	30·340	57	30·266	60	46	39	48	48	59	57	N. W.	2	. .	Fine, breezy, changeable, occasional sunsh.
7 Saturday, . . .	7	30·280	49	30·228	51	39	32	46	48	51	49	N. W.	0	. .	Cloudy, mild, changeable day.
8 Sunday, . . .	8	30·224	57	30·150	58	39	32	48	49	57	55	S. W.	3	. .	Breezy, changeable, occasional sunshine.
9 Monday, . . .	9	30·076	51	30·018	52	40	35	47	49	51	49	S. E.	0	·020	Cloudy, showery, changeable day.
10 Tuesday, . . .	10	29·840	52	29·778	56	44	38	49	50	56	54	S. E.	1	·020	Breezy, light showers, occas. sunsh. day.
11 Wednesday, . .	11	29·050	48	29·999	49	45	39	46	48	49	47	S. E.	0	·230	Strong breezy, wet, changeable day.
12 Thursday, . . .	12	28·918	54	28·058	56	47	39	48	49	56	54	S. W.	2	·070	Strong breezy, showery, occasional sun.
13 Friday, ...	13	29·400	52	29·339	50	45	38	46	48	48	46	S. W.	2	·060	Breezy, showery, occasional sunshine.
14 Saturday, . . .	14	29·600	56	29·527	60	45	39	48	49	60	58	S. W.	2	·060	Do.
15 Sunday, . . .	15	29·700	56	29·627	60	45	40	48	50	59	57	S. W.	1	·040	Showery, changeable, occasional sunshine.
16 Monday, . . .	16	29·772	56	29·699	59	42	35	48	50	59	57	S. W.	2	·190	Breezy, hail showers, occasional sunshine.
17 Tuesday, . . .	17	29·872	56	29·799	57	48	39	49	51	57	56	S. W.	0	·040	Breezy, cloudy, showery, changeable day
18 Wednesday, . .	18	30·050	62	29·960	66	54	46	52	53	65	53	S. W.	3	·020	Breezy, showery, occasional sunshine.
19 Thursday, . . .	19	29·978	59	29·900	60	52	45	51	53	60	58	S. W.	0	. .	Cloudy, breezy, changeable day.
20 Friday, ...	20	29·978	68	29·874	70	56	48	54	54	70	68	S. W.	3	·070	Breezy, showery, occasional sunshine.
21 Saturday, . . .	21	30·000	69	29·894	72	57	50	56	56	72	70	S. W.	4	·030	Do.
22 Sunday, . . .	22	30·090	55	30·027	57	50	43	53	55	56	54	S. W.	0	. .	Breezy, cloudy, changeable day.
23 Monday, . . .	23	30·334	57	30·260	58	40	34	50	52	58	56	S. W.	0	. .	Do.
24 Tuesday, . . .	24	30·272	60	30·177	63	54	48	52	54	62	60	N. W.	2	. .	Breezy, changeable, occasional sun.
25 Wednesday, . .	25	30·450	62	30·360	66	41	35	52	54	65	63	N. E.	8	. .	Fine, breezy, bright, sunshine day.
26 Thursday, . . .	26	30·364	62	30·274	63	41	35	53	55	62	60	S. E.	8	. .	Do.
27 Friday, ...	27	30·200	64	30·099	66	43	39	54	55	65	64	S. E.	8	. .	Do.
28 Saturday, . . .	28	30·034	59	29·955	60	48	44	54	55	59	57	S. E.	1	. .	Breezy, cloudy, changeable, occasional sun.
29 Sunday, . . .	29	29·908	68	29·820	66	53	49	55	57	65	63	S. E.	2	·060	Cloudy, showery, occasional sunshine day.
30 Monday, . . .	●	29·446	54	29·875	58	53	49	54	56	56	55	S. W.	0	·100	Breezy, showery, cloudy, changeable.
31 Tuesday, . . .	1	29·574	56	29·501	59	48	42	52	54	58	56	N. W.	0	·050	Do.
													62	1·100	inches.

JUNE, 1870.

DATE. Day, At 12 o'Clock, P. M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Cor-rected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
			°		°	°	°	°	°	°	°				
1 Wednesday, .	2	29·750	56	29·679	59	45	41	51	53	58	56	W	0	. .	Fine, mild, cloudy, changeable day.
2 Thursday, . .	3	29·988	61	29·905	63	56	51	54	56	61	60	N. W.	0	·080	Breezy, cloudy, light showers.
3 Friday, . . .	4	30 046	58	29·967	60	52	48	54	56	60	58	S. E.	0	. .	Breezy, cloudy, changeable day.
4 Saturday, . .	5	30·332	69	30·226	73	50	46	56	57	71	70	S. E.	2	. .	Cloudy, mild, occasional sunshine day.
5 Sunday, . . .	6	30·550	71	30·437	73	48	48	57	58	72	69	S. E.	8	. .	Fine, breezy, warm, bright sunshine day.
6 Monday, . . .	7	30·576	74	30·424	76	47	44	59	60	76	73	S. E.	8	. .	Do.
7 Tuesday, . . .	8	30·580	70	30·417	71	53	49	60	61	71	67	S. E.	8	. .	Do.
8 Wednesday, .	9	30·250	70	30·159	72	54	49	60	61	71	68	N. W.	5	. .	Breezy, changeable, occasional sunshine.
9 Thursday, . .	10	29·920	61	29·887	63	49	44	56	59	62	60	N. W.	5	. .	Do.
10 Friday, . . .	11	29·696	59	29·618	61	46	42	55	58	60	58	S. W.	1	. .	Breezy, cloudy, changeable, rain-like day.
11 Saturday, . .	12	29 724	59	29·646	61	50	46	54	56	60	58	N. W.	0	. .	Do.
12 Sunday, . . .	13	29·988	60	29·905	62	51	46	54	56	61	60	S. W.	0	·230	Breezy, cloudy, wet, changeable day.
13 Monday, . . .	14	30·050	66	29·949	67	57	51	57	58	65	63	S. W.	7	. .	Fine, breezy, bright sunshine day.
14 Tuesday, . .	15	30·024	69	29·945	72	52	47	58	59	71	68	S. W.	6	. .	Do.
15 Wednesday, .	16	30·000	60	29·915	62	57	56	56	58	61	59	S. W.	0	·040	Breezy, cloudy, light showers.
16 Thursday, . .	17	29·900	59	29·822	60	56	49	56	58	60	58	S. W.	0	·210	Cloudy, mild, wet, changeable day.
17 Friday, . . .	18	29·900	60	29·817	62	52	48	55	57	61	59	N. E.	2	·180	Cloudy, changeable, occasional sunshine.
18 Saturday, . .	19	29·980	67	29·881	69	55	49	58	59	68	65	N. W.	6	. .	Fine, breezy, bright sunshine day.
19 Sunday. . . .	20	30·050	69	29·944	70	56	51	59	60	70	68	S. W.	4	. .	Breezy, changeable, occasional sunshine.
20 Monday, . .	21	30·228	68	30·122	70	56	51	59	60	70	68	S. W.	6	. .	Do.
21 Tuesday, . .	22	30·280	73	30·163	74	61	56	62	62	73	70	S. E.	0	. .	Cloudy, mild, overcast, changeable day.
22 Wednesday, .	23	30·300	65	30·305	68	57	51	60	62	67	65	N. W.	3	. .	Breezy, changeable, occasional sunshine day.
23 Thursday, . .	24	30·280	60	30·185	62	43	39	57	60	61	59	N. W.	4	.	Do.
24 Friday, . .	25	30·020	60	29·935	64	51	45	56	59	63	60	N. W.	2	·060	Breezy, showery, occasional sunshine day.
25 Saturday, . .	26	30·272	58	30·195	61	47	42	55	58	61	58	N. W.	1	. .	Breezy, changeable, occasional sunshine.
26 Sunday, . . .	27	30·000	58	29·921	59	53	49	54	57	59	57	S. W.	0	. .	Breezy, cloudy, rain-like day.
27 Monday, . . .	28	30·048	58	29·969	60	51	46	55	57	60	58	S. W.	0	. .	Do.
28 Tuesday, . . .	●	30·160	57	30·086	60	52	47	54	56	59	57	W.	0	. .	Cloudy, mild, changeable day.
29 Wednesday, .	1	30·150	60	30·065	62	52	48	55	57	62	59	N. W.	0	. .	Breezy, cloudy, changeable day.
30 Thursday, . .	2	30·100	56	30·026	58	48	43	53	56	57	55	N. W.	0	. .	Do.
													78	750	inches.

JULY, 1870.

DATE.	MOON'S AGE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.		Observed Height.	Therm.	Corrected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
			°		°	°		°	°	°	°				
1 Friday, . . .	3	30·062	58	29·983	60	49	44	53	56	59	57	N. W.	2	·020	Breezy, showery. occasional sunshine.
2 Saturday, . .	4	30·020	59	29·941	60	51	46	54	56	60	59	S. W.	0	. .	Cloudy, mild, changeable day.
3 Sunday, . . .	5	29·878	60	29·795	62	51	48	54	57	61	59	S. W.	0	. .	Cloudy, mild, overcast, changeable day.
4 Monday, . . .	6	29·736	66	29·637	68	59	54	58	59	68	65	S. W.	1	·130	Breezy, showery, occasional sunshine.
5 Tuesday, . . .	7	29·800	63	29·712	66	55	50	57	59	65	63	S. W.	2	.020	Do.
6 Wednesday,. .	8	29·926	64	29·832	68	51	46	57	59	67	65	N. W.	4	. .	Breezy, changeable, occasional sunshine.
7 Thursday, . .	9	30·040	65	29·945	67	46	41	57	58	67	64	S. W.	3	. .	Fine, mild, overcast, occas. sunshine day.
8 Friday, . . .	10	29·920	73	29·805	75	61	56	60	61	74	70	S. W.	3	·020	Breezy, light showers, occasional sunshine.
9 Saturday, . .	11	29·862	69	29·758	72	60	55	63	63	73	69	S. W.	2	. .	Cloudy, overcast, occasional sunshine day.
10 Sunday, . . .	12	29·826	66	29·727	67	59	51	60	62	66	64	S. W.	2	·100	Cloudy, showery, occasional sunshine day.
11 Monday, . . .	13	29 750	68	29·646	69	55	50	60	62	68	65	S. W.	4	. .	Breezy, changeable, occasional sunshine.
12 Tuesday,. . .	14	29·750	66	29 661	68	53	49	59	61	65	63	S. E.	5	. .	Do.
13 Wednesday, .	15	29·820	64	29·726	65	59	54	60	62	63	60	S. W.	5	·190	Breezy, showery, occasional sunshine.
14 Thursday, . .	16	29·930	63	29·842	65	56	51	59	61	64	61	S. W.	0	. .	Cloudy, breezy, changeable day.
15 Friday, . . .	17	29·748	64	29·654	65	56	54	59	61	64	62	S. E.	0	. .	Cloudy, mild, rain-like day.
16 Saturday, . .	18	29·710	65	29·616	67	53	49	59	61	67	64	S. W.	3	·250	Breezy, showery, occasional sunshine.
17 Sunday, . . .	19	29·994	60	29·911	62	54	50	57	59	61	58	S. W.	0	·100	Cloudy, showery, mild, changeable day.
18 Monday, . . .	20	29·994	65	29·900	67	55	51	59	60	66	64	S. W.	0	·080	Do.
19 Tuesday, . . .	21	30·200	69	30·094	71	63	59	61	62	70	67	N. W.	1	·020	Showery, overcast, changeable day.
20 Wednesday,. .	22	30·234	71	30·123	75	56	51	62	63	75	71	N. W.	4	. .	Fine, breezy, occasional sunshine day.
21 Thursday, . .	23	30·142	70	30·031	73	63	58	63	64	73	69	N. W.	2	. .	Do.
22 Friday, . . .	24	30·172	70	30·061	70	61	55	65	66	70	67	S. E.	2	. .	Do.
23 Saturday, . .	25	30·008	74	29·886	74	57	55	64	66	74	70	S. E.	7	. .	Fine, breezy, bright sunshine day.
24 Sunday, . . .	26	29·950	79	29·825	80	57	52	66	67	80	76	S. E.	8	. .	Do.
25 Monday, . . .	27	29·900	73	29·785	76	58	52	65	66	75	70	N. W.	8	. .	Fine, mild, overcast, changeable day.
26 Tuesday, . . .	28	30·132	67	30·031	69	51	46	62	65	68	65	N. E	8	. .	Fine, breezy, bright, sunshine day.
27 Wednesday,. .	29	30·200	68	30·094	71	48	42	61	63	70	66	N. E.	8	. .	Do.
28 Thursday, . .	●	30·278	69	30·172	71	54	49	64	65	71	67	N. E.	8	. .	Do.
29 Friday, . . .	1	30·200	70	30·089	72	47	43	63	65	72	69	N. E.	8	. .	Do.
30 Saturday, . .	2	30·044	63	29·954	65	48	44	62	64	64	61	S. E.	2	. .	Breezy, changeable, occasional sunshine.
31 Sunday, . . .	3	29·878	65	29·784	67	60	57	62	64	67	64	N. E.	0	. .	Cloudy, mild, overcast day.
													97	·930	inches.

AUGUST, 1870.

DATE. Day, At 12 o'Clock, P. M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN. IN INCH.	WEATHER, AND GENERAL REMARKS.
			°		°	°	°	°	°	°	°				
1 Monday, . . .	4	29·878	70	29·769	73	60	55	65	65	73	69	N. E.	0	. .	Cloudy, mild, overcast day.
2 Tuesday, . .	5	29·900	72	29·785	75	60	55	65	66	75	70	S. E.	2	. .	Fine, mild, changeable, occasional sunsh.
3 Wednesday, .	6	29·800	72	29·685	78	54	50	65	66	78	69	S. E.	8	. .	Do.
4 Thursday, . .	7	29·612	66	29·523	68	61	54	64	66	68	65	N. E.	2	·840	Cloudy, showery, occasional sunshine.
5 Friday, . . .	8	29·590	62	29·510	64	52	46	61	64	64	60	S. E.	2	·130	Do.
6 Saturday, . .	9	29·808	67	29·709	70	56	51	62	63	70	66	S. E.	5	. .	Breezy, changeable, occasional sunshine.
7 Sunday, . . .	10	29·680	64	29·586	68	58	55	61	63	68	65	S. E.	1	·210	Breezy, showery, occasional sunshine.
8 Monday, . . .	11	30·000	70	29·889	72	58	55	65	66	72	68	S. E.	2	. .	Cloudy, mild, occasional sunshine day.
9 Tuesday, . .	12	30·180	72	30·063	73	55	51	64	65	73	69	S. E.	6	. .	Fine, breezy, bright sunshine day.
10 Wednesday, .	13	30·222	73	30·105	75	49	46	63	65	74	70	S. E.	6	. .	Do.
11 Thursday, . .	14	31·276	78	30·143	81	49	46	64	66	81	76	S. E.	6	. .	Do.
12 Friday, . . .	15	30·320	76	30·193	77	54	49	65	66	77	73	N. E.	6	. .	Do.
13 Saturday, . .	16	30·320	75	30·198	78	50	46	65	67	77	73	N. E.	6	. .	Do.
14 Sunday, . . .	17	30·300	66	30·199	67	54	51	63	66	66	68	N. E.	5	. .	Breezy, changeable, occasional sunshine.
15 Monday, . . .	18	30·178	64	30·083	66	52	50	62	64	66	64	N. E.	4	. .	Do.
16 Tuesday, . .	19	30·168	70	30·057	72	51	49	63	65	71	66	N. E.	6	. .	Fine, breezy. bright sunshine day.
17 Wednesday, .	20	30·120	72	29·998	74	44	42	62	64	74	69	N. E.	6	. .	Do.
18 Thursday, . .	21	30·000	64	29·995	68	50	48	61	64	67	64	N. E.	0	. .	Breezy, cloudy, changeable.
19 Friday, . . .	22	30·028	64	29·933	65	49	46	60	63	65	62	N. E.	4	. .	Breezy, changeable, occasional sunshine.
20 Saturday, . .	23	30·130	63	30·040	65	43	40	59	62	64	61	N. E.	5	. .	Do.
21 Sunday, . . .	24	30·228	61	30·143	65	40	87	57	60	68	60	N. E.	4	. .	Breezy, changeable, occasional sunshine.
22 Monday, . . .	25	29·850	59	29·772	60	43	40	57	60	60	57	N. W.	0	·150	Breezy, showery, changeable day.
23 Tuesday, . . .	26	29·900	62	29·812	64	51	47	57	59	64	60	N. W.	1	·140	Breezy, showery, occasional sunshine.
24 Wednesday, .	27	29·928	64	29·934	65	50	48	56	59	64	60	S. W.	4	. .	Breezy, changeable, occasional sunshine.
25 Thursday, . .	28	30·040	64	29·945	67	50	45	57	59	66	63	N. W.	4	. .	Do.
26 Friday, . . .	●	29·974	62	29·886	64	49	46	56	59	64	61	N. W.	3	. .	Do.
27 Saturday, . .	1	29·840	56	29·767	58	48	44	54	56	57	54	S. E.	0	·050	Cloudy, mild, light showers.
28 Sunday, . . .	2	29·588	58	29·510	58	51	49	56	58	57	54	S. E.	2	·470	Breezy, cloudy, occasional sunshine.
29 Monday, . . .	3	29·950	59	29·872	61	43	40	53	56	61	59	N. E.	3	. .	Do.
30 Tuesday, . .	4	30·240	61	30·155	64	42	39	53	56	63	60	N. W.	3	. .	Do.
31 Wednesday, . .	5	30·188	62	30·098	65	45	41	53	56	65	61	S. W.	5	. .	Fine, breezy, bright sunshine.
													·107	1·490	

SEPTEMBER, 1870.

DATE. Day, At 12 o'Clock, P. M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
			°		°	°	°	°	°	°	°				
1 Thursday, . . .	6	29·640	65	29·545	66	52	48	56	58	67	64	S. W.	0	. .	Breezy, cloudy, changeable day.
2 Friday, . . .	7	29·328	64	29·236	66	51	47	55	57	66	63	S. W.	8	·880	Breezy, occasional sun, heavy rain.
3 Saturday, . . .	8	29·650	58	29·572	60	49	45	54	57	65	57	N. W.	8	·050	Breezy, showery, occasional sunshine.
4 Sunday, . . .	9	29·750	64	29·654	68	46	42	54	56	68	65	S. W.	4	·040	Do.
5 Monday, . . .	10	29·450	64	29·358	67	55	50	55	57	65	62	S. W.	4	·200	Breezy, heavy showers, occasional sunshine
6 Tuesday, . . .	11	29·266	62	29·179	64	46	42	58	56	64	61	N. W.	5	·040	Breezy, light showers, bright sunshine.
7 Wednesday, . .	12	29·262	57	29·191	59	46	42	53	56	58	55	N. W.	3	. .	Breezy, cloudy, occasional sunshine.
8 Thursday, . . .	13	29·682	58	29·604	61	43	39	52	55	61	58	N. W.	4	·100	Breezy, showery, occasional sunshine.
9 Friday, ...	14	29·164	60	29·082	61	54	50	54	56	61	59	S. W.	4	·040	Stormy, showery, occasional sunshine.
10 Saturday, . . .	15	29·712	56	29·639	58	50	45	51	54	57	55	S. W.	2	·050	Breezy, showery, occasional sunshine.
11 Sunday, . . .	16	30·100	59	30·021	62	43	39	51	54	62	58	S. E.	6	. .	Fine, mild, bright sunshine day.
12 Monday, . . .	17	29·968	60	29·885	62	48	44	52	54	62	59	S. E.	2	·060	Breezy, showery, occasional sunshine.
13 Tuesday, . . .	18	29·812	59	29·734	60	54	50	53	55	60	57	S. W.	0	130	Breezy, showery, changeable day.
14 Wednesday, . .	19	29·972	60	29·889	63	58	49	54	56	62	59	S. E.	3	. .	Cloudy, mild, occasional sunshine day.
15 Thursday, . . .	20	30·190	57	30·116	60	45	41	53	55	60	57	S. E.	0	. .	Cloudy, mild, changeable.
16 Friday, ...	21	30·386	62	30·296	63	56	52	55	56	62	59	S. E.	0	·170	Do. do., showery.
17 Saturday, . . .	22	30·374	61	30·289	68	56	52	56	58	63	60	S. W.	0	. .	Cloudy, mild, changeable day.
18 Sunday, . . .	23	30·276	57	30·229	58	55	51	56	58	58	56	S. E.	0	. .	Do.
19 Monday, . . .	24	30·200	62	30·110	63	55	51	56	58	63	60	S. W.	0	. .	Do.
20 Tuesday, . . .	25	30·360	65	30·265	67	50	46	56	58	67	64	S. W.	6	. .	Fine, mild, bright sunshine.
21 Wednesday, . .	26	30·272	66	30·171	68	48	44	56	58	67	64	S. E.	6	. .	Do.
22 Thursday, . .	27	30·222	68	30·116	72	48	42	56	58	72	68	S. E.	6	. .	Fine, breezy, bright sunshine.
23 Friday, ...	28	30·222	64	30·127	66	54	48	57	59	66	64	S. E.	6	. .	Do.
24 Saturday, . . .	29	30·172	64	30·077	66	54	48	56	58	66	64	S. E.	3	. .	Cloudy, mild, occasional sunshine.
25 Sunday, . . .	●	30·290	65	30·195	70	49	44	56	58	70	67	S. E.	5	. .	Fine, mild, bright sunshine day.
26 Monday, . . .	1	30·150	64	30·055	65	57	52	57	58	65	62	S. W.	0	. .	Cloudy, mild, foggy, changeable day.
27 Tuesday, . . .	2	30·250	57	30·176	58	51	46	56	58	58	56	S. E.	0	. .	Cloudy, mild, changeable, overcast.
28 Wednesday, . .	3	30·280	55	30·212	58	51	48	55	57	58	56	S. E.	1	. .	Foggy, overcast, occasional sunshine.
29 Thursday, . . .	4	30·364	63	30·274	67	42	39	54	56	66	64	S. E.	3	. .	Do.
30 Friday, ...	5	30·426	63	30·336	68	43	39	54	57	68	65	S. E.	3	. .	Do.
													82	1·560	inches.

OCTOBER, 1870.

DATE. Day, At 12 o'Clock, P. M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
			°		°	°	°	°	°	°	°				
1 Saturday, . .	6	30·500	61	30·414	64	47	43	55	57	64	61	S. E.	4	. .	Breezy, foggy, occasional sunshine day.
2 Sunday, . . .	7	30·424	61	30·339	64	42	38	53	56	64	61	S. E.	5	. .	Fine, breezy, bright sunshine day.
3 Monday, . .	8	30·432	62	30·342	65	41	36	53	55	65	63	S. E.	5	. .	Do.
4 Tuesday, . .	9	30·468	58	30·389	63	42	38	52	54	63	60	S. E.	3	. .	Foggy, mild, occasional sunshine day.
5 Wednesday, .	10	30·300	55	30·232	57	47	42	52	54	57	55	N. E.	0	. .	Breezy, foggy, changeable day.
6 Thursday, . .	11	30·026	55	29·985	57	48	42	52	54	57	55	S. E.	0	. .	Cloudy, mild, overcast day.
7 Friday, . . .	12	29·590	59	29·512	61	53	47	53	55	61	58	S. E.	0	·050	Showery, cloudy, changeable day.
8 Saturday, . .	13	29·042	56	28·971	58	55	50	54	55	57	54	S. E.	0	·780	Cloudy, heavy rain, changeable.
9 Sunday, . .	14	29·148	45	29·108	48	44	40	50	53	48	46	N. W.	1	·940	Breezy, heavy rain, occasional sunshine.
10 Monday, . .	15	29·590	49	29 538	52	32	29	46	50	52	49	N. E.	5	. .	Fine, bright, sunshine, light frost.
11 Tuesday, . .	16	29·800	51	29·743	56	34	31	45	49	56	54	N. W.	4	. .	Do.
12 Wednesday, .	17	28·790	59	28·719	60	46	40	49	50	59	56	S. W.	0	·400	Stormy, wet, changeable day.
13 Thursday,* .	18				51		40	46	49			S. W.	0	. .	Very stormy, showery, changeable.
14 Friday, . . .	19				54		39	47	50			N. W.	2	. .	Foggy, occasional sunshine, changeable.
15 Saturday, .	20	29·830			64	32	30	46	49			N. E.	3	. .	Do.
16 Sunday, . . .	21	29·900			59	49	45	50	51			S. W.	2	. .	Strong breezy, occasional sunshine day.
17 Monday, . .	22	29·540			56	41	38	47	50			S. W.	4	. .	Breezy, changeable, occasional sunshine.
18 Tuesday, . .	23	29·510			55	34	32	45	48			S. E.	0	. .	Breezy, changeable, rain-like day.
19 Wednesday, .	24	29·100			57	47	43	47	49			S. E.	2	. .	Breezy, heavy rain, occasional sunshine.
20 Thursday, . .	25	29·470			51	37	35	44	47			S. W.	0	. .	Stormy, showery, changeable day.
21 Friday, . . .	26	29·930			56	39	36	44	47			S. W.	0	. .	Cloudy, mild, changeable day.
22 Saturday, . .	27	29·670			62	50	47	49	50			S. W.	1	. .	Fine, mild, changeable, occasional sunshine.
23 Sunday, . . .	28	28·680			55	46	43	47	49			S. W.	0	. .	Breezy, showery, changeable day.
24 Monday, . .	●	29·050			54	44	42	46	49			S. W.	0	. .	Breezy, cloudy, changeable day.
25 Tuesday, . .	1	29·550			54	40	39	45	47			N. W.	2	. .	Breezy, changeable, occasional sun.
26 Wednesday, .	2	29·450			55	39	37	43	46			S. W.	2	. .	Do.
27 Thursday, . .	3	29·530			52	41	38	43	45			S. W.	1	. .	Breezy, showery, occasional sunshine.
28 Friday, . . .	4	29·970			55	44	41	45	47			S. W.	2	. .	Do.
29 Saturday, . .	5	29·700			57	49	46	47	48			S. W.	0	. .	Breezy, wet, changeable day.
30 Sunday, . . .	6	29·840			54	37	35	44	47			S. W.	3	. .	Breezy, changeable, occasional sunshine.
31 Monday, . .	7	29·760			55	46	43	46	48			S. W.	2	. .	Breezy, wet, occasional sunshine day.
													53	2·170	inches.

* Record incomplete from the 13th October tothe 17th November, in consequence of the Observatory having been damaged by a storm.

NOVEMBER, 1870.

Date. Day, At 12 o'Clock, P. M.	Moon's Age.	Barometer. Observed height	Barometer. Therm.	Barometer. Corrected.	Thermometers. Max.	Thermometers. Min.	Thermometers. On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Wind. Direction.	Hours of Sunshine.	Rain in Inch.	Weather, and General Remarks.
			°		°	°	°	°	°		°				
1 Tuesday, . . .	8	30·450			62	34	31	44	45			S. E.	4		Fine, mild, bright sunshine day.
2 Wednesday, . .	9	30·430			55	30	29	42	45			S. W.	2		Breezy, changeable, occasional sunshine.
3 Thursday, . . .	10	30·500			52	40	38	44	46			N. W.	0		Cloudy, mild, overcast, changeable.
4 Friday, . . .	11	30·540			53	43	40	45	47			S. E.	0		Do.
5 Saturday, . . .	12	30·520			53	49	47	44	46			N. E.	0		Do.
6 Sunday, . . .	13	30·290			59	35	34	43	45			S. W.	3		Breezy, changeable, occasional sunshine.
7 Monday, . . .	14	29·740			54	34	33	43	46			N. W.	4		Fine, breezy, bright sunshine day.
8 Tuesday, . . .	15	29·740			46	27	26	39	43			N. E.	0		Cloudy, mild, light frost, changeable.
9 Wednesday, . .	16	29·960			52	34	32	41	44			N. E.	3		Fine, breezy, bright sunshine day.
10 Thursday, . . .	17	29·780			40	29	27	37	41			N. E.	2		Breezy, cold, occasional sunshine.
11 Friday, ...	18	29·830			42	30	29	37	40			N. W.	2		Do.
12 Saturday, . . .	19	29·410			40	28	27	36	38			N. W.	0		Breezy, cold, rain-like day.
13 Sunday, . . .	20	29·430			48	31	29	37	39			S. W.	3		Breezy, changeable, occasional sunshine.
14 Monday, . . .	21	29·160			47	33	31	38	40			S. W.	3		Do.
15 Tuesday, . . .	22	29·180			45	28	27	36	39			N. W.	2		Breezy, showery, occasional sunshine.
16 Wednesday, . .	23	29·220			45	31	29	37	38			N. W.	2		Breezy, cold, occasional sunshine day.
17 Thursday, . . .	24	29·550	42	29·464	44	28	25	36	38	44	42	N. W.	2	. .	Do.
18 Friday, ...	25	29·572	39	29·547	42	33	31	36	38	44	41	N. W.	3	. .	Do.
19 Saturday, . . .	26	29·080	39	29·055	41	35	34	36	38	42	40	N. W.	0	·330	Cloudy, cold, wet, changeable.
20 Sunday, . . .	27	29·164	44	29·132	47	33	30	37	39	48	44	S. W.	2	·040	Breezy, changeable, occasional sunshine.
21 Monday, . . .	28	29·092	44	29·050	45	39	35	38	40	48	45	S. W.	2	·120	Do.
22 Tuesday, . . .	29	28·980	39	28·956	42	34	31	37	39	48	41	S.	0	·060	Cloudy, cold, wet, changeable day.
23 Wednesday, . .	●	29·100	45	29·060	47	40	37	39	41	49	46	S. W.	3	·150	Fine, breezy, changeable, occas. sunshine.
24 Thursday, .	1	28·950	49	28·900	50	41	38	41	42	52	49	S. W.	1	·060	Cloudy, mild, occasional sunshine day.
25 Friday, ...	2	29·292	45	29·252	48	40	37	41	43	51	47	S. W.	2	. .	Fine, mild, occasional sunshine day.
26 Saturday, . . .	3	29·762	42	29·726	45	35	31	39	41	47	45	N. W.	0	. .	Cloudy, mild, changeable day.
27 Sunday, . . .	4	30·084	44	30·042	49	35	32	40	42	51	47	S. E.	2	. .	Fine, mild, occasional sunshine day.
28 Monday, . . .	5	30·114	47	30·067	48	46	41	41	42	49	46	S. E.	0	. .	Breezy, cloudy, changeable day.
29 Tuesday, . . .	6	30·164	48	30·112	48	47	43	43	44	50	47	S. E.	0	. .	Do.
30 Wednesday, . .	7	30·340	45	30·298	45	44	40	42	43	47	44	S. E.	0	. .	Do.
													46	·760	inches.

DECEMBER, 1870.

DATE. Day, At 12 o'Clock, P. M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
1 Thursday, . . .	8	30·470	42°	30·434	43°	40°	36°	40°	43°	45°	42°	S. E.	2	. .	Breezy, cold, occasional sunshine.
2 Friday, ...	9	30·522	37	30·501	37	37	34	39	41	40	38	S E.	0	. .	Breezy, cold, changeable day.
3 Saturday, . . .	10	30·400	37	30·380	38	35	32	37	40	40	38	N. W.	0	. .	Do.
4 Sunday, . . .	11	30·328	42	30·282	44	39	35	38	40	45	42	N. W.	0	. .	Cloudy, mild, changeable day.
5 Monday, . . .	12	30·328	42	30·282	43	37	32	39	41	45	42	S. W.	2	. .	Fine, mild, occasional sunshine.
6 Tuesday, . . .	13	29·972	41	29·942	43	36	31	38	40	45	42	S. E.	2	. .	Occasional sun, hail showers.
7 Wednesday, . .	14	29·928	35	29·913	38	31	27	36	39	41	38	N. W.	2	. .	Breezy, occasional sun, changeable.
8 Thursday, . . .	15	29·578	31	29·574	35	27	24	33	37	38	35	N. W.	1	. .	Occasional sun, frost, changeable.
9 Friday, ...	16	29·700	30	29·696	31	26	23	32	35	35	33	N. W.	0	. .	Cloudy, cold, snow showers.
10 Saturday, . . .	17	29·900	30	29·896	33	26	23	32	35	35	33	N. W.	1	. .	Cloudy, frosty, occasional sunshine.
11 Sunday, . . .	18	29·650	37	29·180	39	34	30	33	36	41	38	S. E.	0	·210	Breezy, showery, changeable.
12 Monday, . . .	19	29·060	43	29·025	44	39	35	36	37	46	44	S. W.	2	·540	Breezy, changeable, occasional sunshine, wet.
13 Tuesday, . .	20	29·332	31	29·328	31	30	27	35	37	34	32	N. E.	1	·060	Do.
14 Wednesday, . .	21	28·720	49	28·670	49	33	29	37	38	51	47	S. W.	0	·370	Breezy, wet, changeable day.
15 Thursday, . . .	22	29·388	44	29·348	45	44	40	39	40	46	43	N. W.	0	. .	Cloudy, mild, changeable day.
16 Friday, ...	23	29·800	38	29·774	40	29	25	36	39	42	39	S. W.	0	. .	Do.
17 Saturday, . . .	24	30·016	34	30·001	37	26	24	34	37	40	38	N. W.	1	. .	Breezy, cold, occasional sunshine.
18 Sunday, . . .	25	30·016	47	29·965	48	36	34	38	39	50	47	S. W.	0	. .	Breezy, cloudy, changeable day.
19 Monday, . . .	26	29·672	50	29·615	51	47	45	33	43	53	49	S. W.	0	·250	Breezy, wet, changeable.
20 Tuesday, . . .	27	29·628	42	29·592	43	39	36	40	42	46	43	S. W.	2	·200	Breezy, showery, occasional sunshine.
21 Wednesday, . .	28	29·800	35	29·785	36	33	30	36	39	37	34	S. W.	0	·190	Breezy, cloudy, cold, showery.
22 Thursday, . . .	●	29·940	30	29·936	31	29	25	33	36	34	30	N. E.	2	. .	Breezy, cold, occasional sunshine.
23 Friday, ...	1	29·900	27	29·893	31	23	20	33	35	34	30	S. E.	2	. .	Do.
24 Saturday, . . .	2	29·580	34	29·565	36	23	20	32	34	37	35	S. E.	2	. .	Do.
25 Sunday, . . .	3	29·816	26	29·767	30	20	18	30	33	32	30	N. W.	1	. .	Cloudy, overcast, occasional sunshine.
26 Monday, . . .	4	30·000	32	29·991	35	25	22	30	32	32	30	N. E.	1	. .	Do.
27 Tuesday, . . .	5	29·800	33	29·791	34	27	24	30	33	36	33	N. E.	1	. .	Do.
28 Wednesday, . .	6	29·950	32	29·941	34	32	28	30	33	36	34	S E.	2	. .	Occasional sun and snow showers.
29 Thursday, . . .	7	30·084	33	30·071	35	29	24	30	33	36	34	S. E.	1	. .	Breezy, changeable, occasional sunshine.
30 Friday, ...	8	30·132	29	30·131	32	25	21	30	33	33	31	W.	2	. .	Occasional sun, snow showers.
31 Saturday, . . .	9	30·132	29	30·131	31	19	16	30	32	33	31	S. E.	1	. .	Occasional sun, overcast, changeable.
													31	1·820	inches.

JANUARY, 1871.

DATE.	MOON'S AGE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.		Observed Height.	Therm.	Cor-rected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
			°		°		°	°			°				
1 Sunday, . . .	10	29·600	41	29·570	42	31	26	31	33	44	41	S. E.	0	·050	Breezy, cloudy, showery day.
2 Monday, . . .	11	29·740	35	29·725	37	31	29	32	34	39	36	N. W.	2	·200	Fine, bright sun, light frost.
3 Tuesday, . . .	12	29·950	37	29·930	40	30	29	33	34	44	41	S. E.	1	. .	Occasional sun, cloudy, changeable.
4 Wednesday, . .	13	29·876	39	29·851	42	32	30	33	34	44	41	S. E	0	. .	Mild, cloudy, and changeable.
5 Thursday, . .	14	29·774	40	29·734	41	38	35	35	36	43	40	S. W.	2	·060	Breezy, occasional sunshine.
6 Friday, . . .	15	29·774	47	29·728	49	35	32	36	37	50	47	S. W.	0	·080	Breezy, showery, changeable day.
7 Saturday, . .	16	29·440	37	29·420	38	35	32	36	38	39	37	S. W.	2	·130	Breezy, snow showers, occasional sunshine.
8 Sunday, . . .	17	29·550	36	29·536	36	32	29	33	35	37	35	S. W.	3	·080	Breezy, cold, bright sun, changeable.
9 Monday, . . .	18	29·550	39	29·524	40	35	31	34	36	41	39	S. W.	2	·170	Breezy, showery, changeable.
10 Tuesday, . . .	19	29·350	37	29·330	37	33	29	33	35	38	36	N. W.	0	·080	Do.
11 Wednesday, .	20	29·950	37	29·935	37	33	30	33	35	38	36	S. E.	2	·420	Breezy, cold, bright sunshine, wet.
12 Thursday, . .	21	30·160	33	30·157	35	28	25	32	34	36	35	N. W.	1	. .	Cloudy, mild, occasional sunshine.
13 Friday, . . .	22	30·000	43	29·964	45	34	32	35	36	47	45	S. W.	2	. .	Fine, breezy, bright sunshine.
14 Saturday, . .	23	29·520	48	29·468	49	44	40	38	39	52	49	S. W.	3	. .	Do.
15 Sunday, . . .	24	29·142	42	29·107	44	39	35	38	39	46	44	S. W.	3	·430	Breezy, wet, bright sunshine day.
16 Monday, . . .	25	28·564	39	28·540	40	35	31	56	37	41	39	S. W.	2	·300	Stormy, wet, changeable.
17 Tuesday, . . .	26	28·650	40	28·862	42	34	30	35	37	43	40	S. W.	2	. .	Fine, breezy, bright sunshine.
18 Wednesday, . .	27	28·994	33	28·985	37	30	28	34	36	39	37	S. W.	1	. .	Cloudy, mild, occasional sunshine.
19 Thursday, . .	28	29·250	39	29·225	41	28	25	34	35	43	40	S. W.	1	·100	Breezy, showery, occasional sunshine.
20 Friday, . . .	29	29·550	33	29·547	34	30	29	33	35	36	34	S. W.	0	·120	Showery, cold, changeable day.
21 Saturday, . .	●	29·400	37	29·420	38	31	29	33	35	39	37	S. E.	0	400	Foggy, wet, changeable, cold day.
22 Sunday, . . .	1	29·540	36	29·520	38	32	29	34	35	40	37	N. E.	0	·230	Showery, cloudy, cold day.
23 Monday, . . .	2	29·900	35	29·885	36	34	31	33	35	38	36	N. W.	0	. .	Cloudy, cold, changeable.
24 Tuesday, . . .	3	30·178	34	29·163	37	31	29	33	35	39	37	N. E.	2	·100	Showery, changeable, occasional sun.
25 Wednesday, . .	4	30·100	34	30·083	35	34	30	33	35	36	34	N. E.	0	.	Breezy, cloudy, cold day.
26 Thursday, . .	5	30·020	29	30·019	31	26	23	31	33	33	32	W.	0	. .	Do.
27 Friday, . . .	6	30·130	36	30·110	38	30	27	32	34	40	38	S. E.	0	. .	Breezy, cloudy, changeable.
28 Saturday, . .	7	30·100	33	30·091	34	33	30	32	33	36	35	S. E.	1	. .	Breezy, cold, occasional sun.
29 Sunday, . . .	8	30·080	35	30·065	36	32	29	32	34	38	36	S. E.	1	. .	Do.
30 Monday, . . .	9	30 046	35	30·031	36	33	30	33	35	38	36	S. E.	1	. .	Do.
31 Tuesday, . . .	10	29·950	37	29·930	38	33	30	33	35	40	37	S. E.	0	·100	Breezy, showery, cold day.
													34	3·050	inches.

FEBRUARY, 1871.

DATE. Day, At 12 o'Clock, P. M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
1 Wednesday, .	11	29·996	34°	29·981	34°	34°	30°	32°	34°	36°	35°	N. E.	0	·050	Breezy, showery, cold day.
2 Thursday, . .	12	29·850	35	29·835	37	33	30	32	34	39	37	S. E.	0	. .	Cloudy, mild, changeable day.
3 Friday, . . .	13	29·428	43	29·993	44	37	34	35	36	46	43	S. E.	0	·250	Breezy, wet, changeable.
4 Saturday, . .	14	29·428	43	29·993	44	41	38	36	37	46	43	S. E.	0	·040	Breezy, showery, changeable.
5 Sunday, . .	15	29·300	50	29·244	52	43	40	40	40	54	51	S. E.	1	·060	Breezy, showery, occasional sunshine.
6 Monday, . .	16	29·932	46	29·886	49	43	40	40	41	51	48	S. E.	0	·200	Cloudy, mild, changeable day, showery.
7 Tuesday, . .	17	29·932	52	29·876	53	48	44	43	43	55	51	S. W.	0	. .	Breezy, cloudy, changeable.
8 Wednesday, .	18	29·800	49	29·748	50	46	42	43	44	52	49	S. W.	2	. .	Fine, breezy, occasional sunshine.
9 Thursday, . .	19	30·020	44	29·978	47	36	34	40	42	49	46	S. W.	3	·030	Breezy, showery, occasional sunshine.
10 Friday, . . .	20	29·350	39	29·325	40	36	34	38	40	41	39	N. W.	1	·040	Breezy, cloudy, showery day.
11 Saturday, . .	21	29·834	37	29·814	40	30	28	36	39	42	40	S. E.	0	. .	Breezy, cloudy, rain-like day.
12 Sunday, . . .	22	29·350	50	29·294	50	40	36	40	41	51	48	S. W.	2	·050	Breezy, showery, occasional sunshine.
13 Monday, . . .	23	29·890	45	29·849	47	38	35	40	41	49	46	S. W.	2	·050	Do.
14 Tuesday, . .	24	29·890	49	29·838	57	45	41	42	43	53	50	S. W.	0	. .	Breezy, showery, changeable day.
15 Wednesday, .	25	29·990	51	29·833	53	44	40	43	44	54	50	S. W.	3	. .	Fine, breezy, bright sunshine.
16 Thursday, . .	26	29·990	49	29·938	52	39	35	42	43	55	51	S. W.	3	. .	Do.
17 Friday, . . .	27	29·946	50	29·889	52	44	41	43	44	54	50	S. W.	0	. .	Breezy, cloudy, changeable day.
18 Saturday, . .	28	30·000	50	29·942	52	45	42	43	44	54	50	S. W.	0	. .	Do.
19 Sunday, . . .	●	29·700	54	29·633	57	48	45	45	45	59	56	S. W.	3	3·00	Breezy, showery, occasional sunshine.
20 Monday, . .	1	29·740	47	29·694	48	42	38	43	44	50	47	S. W.	3	. .	Fine, breezy, bright, sunshine day.
21 Tuesday, . .	2	30·250	46	30·213	48	40	36	41	43	50	47	S. W.	3	. .	Do.
22 Wednesday, .	3	30·328	47	30·281	48	38	34	40	42	50	47	S. W.	2	. .	Do.
23 Thursday, . .	4	30·328	50	30·270	52	45	42	43	44	54	50	S. W.	3	. .	Do.
24 Friday, . . .	5	30·230	48	30·178	49	42	38	42	43	50	47	N. W.	1	. .	Breezy, cloudy, occasional sunshine.
25 Saturday, . .	6	30·200	45	30·158	47	43	40	42	43	48	46	S. W.	0	.	Cloudy, mild, changeable day.
26 Sunday, . . .	7	29·772	42	29·736	44	38	34	40	42	45	43	S. E.	1	. .	Breezy, cloudy, occasional sunshine.
27 Monday, . .	8	29·550	49	29·498	50	43	40	42	43	52	49	S. W.	0	·260	Breezy, showery, changeable day.
28 Tuesday, . .	9	29·950	47	29·904	47	44	40	43	44	49	46	N. E.	0	·200	Cloudy, showery, changeable day.
													34	1·260	inches.

MARCH, 1871.

DATE. Day At 12 o'Clock, P. M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
			°		°	°	°	°	°	°	°				
1 Wednesday, . .	10	30·200	43	30·164	43	42	39	42	43	45	43	S. W.	0	·070	Breezy, showery, changeable day.
2 Thursday, . . .	11	30·132	51	30·074	52	43	39	42	43	53	50	S. E.	3	·040	Showery occasional, sunshine day.
3 Friday, ...	12	30·050	49	29·998	50	45	41	43	45	52	49	S. E.	3	·020	Do.
4 Saturday, . . .	13	29·750	50	29·693	51	40	36	43	45	53	50	S. E.	3	. .	Fine, breezy, occasional sunshine.
5 Sunday, . . .	14	29·600	54	29·533	56	46	41	45	45	58	55	S. W.	4	. .	Fine, breezy, bright sunshine day.
6 Monday, . . .	15	29·200	50	29·144	51	46	41	44	44	53	49	S. W.	2	. .	Breezy, cloudy, occasional sunshine.
7 Tuesday, . . .	16	29·662	50	29·605	51	36	32	42	44	53	49	S. W.	3	040	Breezy, showery, occasional sunshine.
8 Wednesday, . .	17	29·790	44	29·759	44	38	34	42	44	46	44	S. W.	2	·030	Do.
9 Thursday, . . .	18	29·450	50	29·394	53	37	33	41	43	55	51	N. W.	1	·130	Stormy, showery, occasional sunshine.
10 Friday, ...	19	30 050	47	30·003	49	40	37	40	42	51	48	N. W.	4	. .	Fine, breezy, bright, sunshine day.
11 Saturday, . . .	20	29·750	53	29·688	54	44	40	41	43	55	50	S. W.	0	·100	Breezy, showery, changeable.
12 Sunday, . . .	21	29·250	53	29·181	54	47	42	44	45	56	52	S. W.	1	. .	Strong breezy, occasional sunshine.
13 Monday, . . .	22	29·500	47	29·455	48	37	33	41	43	48	45	N. W.	3	·220	Breezy, showery, occasional sunshine.
14 Tuesday, . . .	23	29·840	37	29·820	40	32	29	37	41	41	38	N. W.	3	. .	Occasional sun, hail showers.
15 Wednesday, . .	24	29·840	37	29·820	40	28	25	36	38	41	38	S. W.	2	. .	Do.
16 Thursday, . . .	25	29·900	40	29·870	42	37	34	37	40	43	41	N. E.	0	·040	Cloudy, cold, light showers.
17 Friday, ...	26	30·200	44	30·158	47	29	26	38	40	49	47	S. W.	2	. .	Fine, breezy, occasional sunshine.
18 Saturday, . . .	27	30·250	51	30·198	53	43	40	42	43	56	53	S. E.	0	. .	Cloudy, mild, changeable day.
19 Sunday, . . .	28	30·180	50	30·122	52	40	36	43	44	54	51	S. W.	4	. .	Fine, mild, bright sunshine.
20 Monday, . . .	29	29·930	49	29·878	50	44	40	43	44	51	49	S. W.	0	. .	Breezy, cloudy, changeable.
21 Tuesday, . . .	●	29·820	50	29·763	52	46	41	43	45	53	50	S. W.	0	. .	Do.
22 Wednesday, . .	1	29·996	49	29·944	51	46	42	43	44	53	50	S. W.	0	. .	Do.
23 Thursday, . . .	2	29·900	50	29·843	52	33	30	43	45	55	52	S. E.	3	. .	Breezy, cloudy, occasional sunshine.
24 Friday, ...	3	29·770	57	29·697	59	42	38	44	46	61	58	S. E.	5	. .	Fine, breezy, bright sunshine.
25 Saturday, . . .	4	29·800	51	29·743	54	35	32	44	45	56	54	S. E.	0	. .	Cloudy, mild, changeable.
26 Sunday, . . .	5	29·967	53	29·914	55	42	39	45	46	56	52	S. E.	4	. .	Fine, breezy, bright sunshine.
27 Monday, . . .	6	30·200	44	30·158	47	32	29	42	44	45	46	N. E.	1	. .	Breezy, cold, occasional sunshine.
28 Tuesday, . . .	7	30·470	42	30·434	43	36	32	41	43	44	41	N. E.	1	. .	Do.
29 Wednesday, . .	8	30·470	45	30·428	47	32	29	43	42	49	46	N. W.	3	. .	Fine, bright sun, light frost.
30 Thursday, . .	9	30·370	45	30·346	48	29	26	39	42	51	48	N. W.	2	. .	Do.
31 Friday, . . .	10	30·100	50	30·042	53	42	39	43	44	55	52	N. W.	2	. .	Breezy, cloudy, occasional sunshine.
													61	·690	inches.

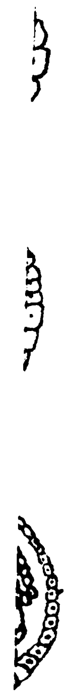
APRIL, 1871.

DATE. Day, At 12 o'Clock, P.M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
			°		°	°	°	°	°	°	°				
1 Saturday, . . .	11	30·028	49	29·976	50	45	41	42	44	52	49	N. W.	0	. .	Breezy, cloudy, changeable day.
2 Sunday, . . .	12	29·840	50	29·783	53	42	38	43	45	55	51	S. W.	1	. .	Breezy, changeable, occasional sun.
3 Monday, . . .	13	29·900	49	29·848	50	39	36	43	45	51	49	N. W.	2	·020	Breezy, changeable, light showers.
4 Tuesday, . . .	14	30·090	52	30·027	54	32	29	42	44	57	54	N. W.	4	. .	Fine, breezy, bright sunshine day.
5 Wednesday, .	15	29·940	49	29·886	50	39	35	43	44	52	50	S. W.	0	·020	Breezy, cloudy, light showers.
6 Thursday, . .	16	30·050	52	29·987	52	40	36	44	45	53	50	S. E.	4	. .	Breezy, foggy, bright sun.
7 Friday, ...	17	30·086	50	30·028	51	41	37	44	45	53	50	N. E.	5	. .	Fine, breezy, bright sunshine day.
8 Saturday, . .	18	30·020	50	29·962	51	29	26	43	45	54	51	N. E.	5	. .	Fine, breezy, bright sun, light frost.
9 Sunday, . . .	19	29·900	52	29·838	52	36	31	43	45	54	51	N. E.	3	. .	Fine, breezy, changeable, occasional snow.
10 Monday, . . .	20	29·930	50	29·873	50	38	33	44	45	52	49	N. E.	4	. .	Do.
11 Tuesday, . . .	21	29·650	46	29·604	46	40	34	42	47	47	45	S. E.	0	·050	Breezy, cloudy, showery day.
12 Wednesday, .	22	29·750	55	29·683	60	40	36	46	48	56	52	S. W.	3	·150	Cloudy, showery, occasional sunshine.
13 Thursday, . .	23	29·900	53	29·838	58	44	39	47	48	60	57	S. W.	4	. .	Cloudy, occasional sun, changeable.
14 Friday, . . .	24	29·570	52	29·516	54	47	43	47	48	55	51	S. E.	3	. .	Do.
15 Saturday, . .	25	29·332	57	29·261	58	47	44	49	50	60	56	S. W.	3	·340	Breezy, showery, occasional sunshine.
16 Sunday, . . .	26	29·320	53	29·259	55	46	41	48	49	55	50	S. E.	2	·240	Cloudy, showery, occasional sunshine.
17 Monday, . . .	27	29·428	50	29·372	50	46	42	47	49	51	48	S. E.	0	·260	Breezy, wet, changeable day.
18 Tuesday, . . .	28	29·332	48	29·287	49	46	42	47	48	50	47	S. E.	0	·250	Do.
19 Wednesday, . .	●	29·000	50	28·944	50	47	43	47	48	52	49	S. W.	0	·400	Do.
20 Thursday, . .	1	29·176	48	29·125	49	43	40	45	47	49	47	S. E.	0	·220	Do.
21 Friday, ...	2	29·550	46	29·504	47	41	37	45	48	50	48	S. E.	0	·120	Do.
22 Saturday, . . .	3	29·524	58	29·446	57	41	37	47	47	61	57	S. W.	4	·100	Breezy, showery, occasional sunshine.
23 Sunday, . . .	4	29·772	52	29·700	58	45	41	46	48	55	52	N. W.	2	. .	Fine, breezy, occasional sunshine day.
24 Monday, . . .	5	29·950	49	29·898	50	43	39	46	48	52	49	N. E.	0	·020	Cloudy, mild, light showers.
25 Tuesday, . . .	6	29·950	47	29·904	47	36	31	44	46	49	46	S. E.	0	0·10	Do.
26 Wednesday, .	7	29·790	56	29·717	57	46	42	47	48	58	55	S. W.	0	·060	Breezy, showery, changeable.
27 Thursday, . .	8	29·700	54	29·633	55	47	43	48	49	57	55	S. W.	2	·070	Breezy, showery, occasional sunshine.
28 Friday, . . .	9	29·682	55	29·615	56	46	42	47	49	57	55	S. W.	1	·110	Do.
29 Saturday, . .	10	29·580	52	29·518	54	47	43	49	50	56	53	S. W.	1	·220	Cloudy, showery, occasional sunshine.
30 Sunday, . . .	11	29·890	53	29·827	55	42	39	48	50	57	54	N. E.	2	. .	Fine, breezy, changeable, occasional sun.
													55	2·660	inches.

MAY, 1871.

DATE. Day, At 12 o'Clock, P.M.	MOON'S AGE.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
			°		°	°	°	°	°	°	°				
1 Monday, . . .	12	30·000	55	29·932	57	33	30	47	49	59	56	N. E.	6	. .	Fine, breezy, bright sunshine.
2 Tuesday, . . .	13	30·000	50	29·942	52	36	34	47	49	54	51	S. E.	2	·090	Showery, changeable, occasional sun.
3 Wednesday, . .	14	29·780	52	29·651	52	46	41	47	49	54	50	N. W.	3	·050	Do.
4 Thursday, . . .	15	30·000	50	29·937	51	41	37	45	47	53	50	N. W.	4	. .	Breezy, changeable, occasional sun.
5 Friday, . . .	16	30·000	59	29·921	61	43	39	48	49	63	59	S. W.	2	·060	Breezy, showery, occasional sun.
6 Saturday, . .	17	30·250	59	30·161	59	43	39	50	51	60	57	N. E.	6	. .	Fine, breezy, bright sunshine.
7 Sunday, . . .	18	30·350	63	30·260	65	43	40	51	53	67	64	S. E.	7	. .	Fine, mild, bright, sunshine day.
8 Monday, . . .	19	30·290	72	30·173	74	43	39	54	54	75	71	S. E.	7	. .	Do.
9 Tuesday, . . .	20	30·290	53	30.227	54	46	41	52	53	55	51	S. E.	4	. .	Breezy, changeable, occasional sun.
10 Wednesday, . .	21	30·250	54	30·182	54	35	32	50	52	56	54	S. E.	3	. .	Do.
11 Thursday, . . .	22	30·128	60	30·033	62	34	31	49	51	64	60	N. W.	6	. .	Fine, mild, bright sunshine.
12 Friday, ...	23	30·056	56	29·982	57	48	43	51	52	59	54	N. E.	4	. .	Breezy, changeable, occasional sunshine.
13 Saturday, . . .	24	30·050	55	29·998	57	39	36	51	52	58	55	S. E.	6	. .	Fine, breezy, bright sunshine day.
14 Sunday, . . .	25	29·900	60	29·817	61	38	34	51	52	62	58	S. E.	4	. .	Breezy, cloudy, occasional sunshine day.
15 Monday, . . .	26	29·900	54	29·833	55	41	38	51	53	57	54	S. E.	0	. .	Breezy, cloudy, changeable.
16 Tuesday, . . .	27	29·930	53	29·868	54	38	34	49	51	56	53	S. W.	0	. .	Do.
17 Wednesday, . .	28	30·050	53	29·987	54	35	32	47	50	56	53	N. W.	6	. .	Fine, bright sunshine, breezy day.
18 Thursday, . . .	29	29·950	56	29·877	58	48	44	49	51	60	57	N. W.	0	·020	Breezy, cloudy, light showers.
19 Friday, . . .	●	30·200	58	30·121	58	49	45	50	52	59	56	S. W.	2	·040	Occasional sun, light showers.
20 Saturday, . . .	1	30·294	62	30·204	63	45	41	51	53	64	60	S. W.	6	. .	Fine, breezy, bright sunshine.
21 Sunday, . . .	2	30·294	62	30·204	63	48	44	54	55	65	61	S. E.	4	. .	Breezy, cloudy, occasional sunshine.
22 Monday, . . .	3	30·104	62	30·044	63	42	39	54	56	64	60	N. E.	7	. .	Fine, breezy, bright sunshine.
23 Tuesday, . . .	4	29·900	58	29·822	58	46	40	54	55	59	56	S. E.	2	. .	Breezy, changeable, occasional sunshine.
24 Wednesday, . .	5	29·800	57	29·727	58	51	46	53	55	60	56	S. E.	0	. .	Breezy, cloudy, changeable day.
25 Thursday, . .	6	29·800	62	29·712	63	47	42	54	55	64	60	S. E.	6	. .	Fine, breezy, bright sunshine day.
26 Friday, ...	7	29·950	57	29·877	57	44	59	52	54	59	54	N. W.	4	. .	Breezy, changeable, occasional sun.
27 Saturday, . . .	8	30·090	59	29·911	60	45	40	53	55	62	59	N. W.	0	. .	Breezy, cloudy, changeable.
28 Sunday, . . .	9	30·340	63	30·250	64	44	40	55	56	66	62	N. W.	3	. .	Breezy, cloudy, occasional sunshine.
29 Monday, . . .	10	30·340	67	30·239	69	46	43	57	58	70	67	N. E.	7	. .	Fine, breezy, bright sunshine.
30 Tuesday, . . .	11	30·266	72	30·149	74	45	42	58	59	75	70	N. E.	7	. .	Do.
31 Wednesday, . .	12	30·176	67	30·075	68	47	43	57	59	69	65	N. E.	7	. .	Do.
													125	·260	inches.

Plate I.



DATE.	BAROMETER.	THERMOMETER.

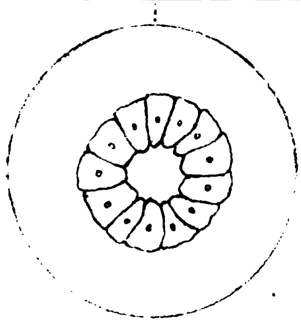


Fig. 2.

Fig. 1.

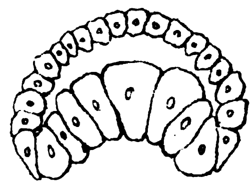


Fig. 3.

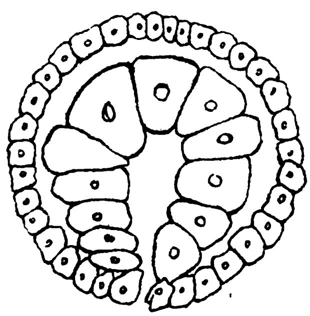


Fig. 4.

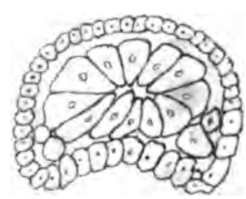


Fig. 5.

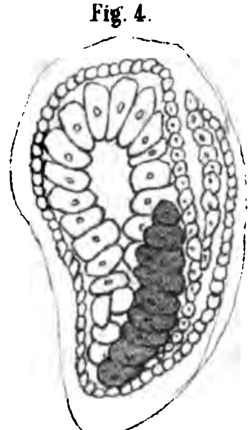


Fig. 6.

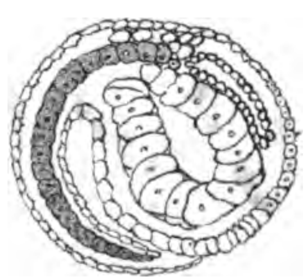


Fig. 7.

Forster & Co Dublin.

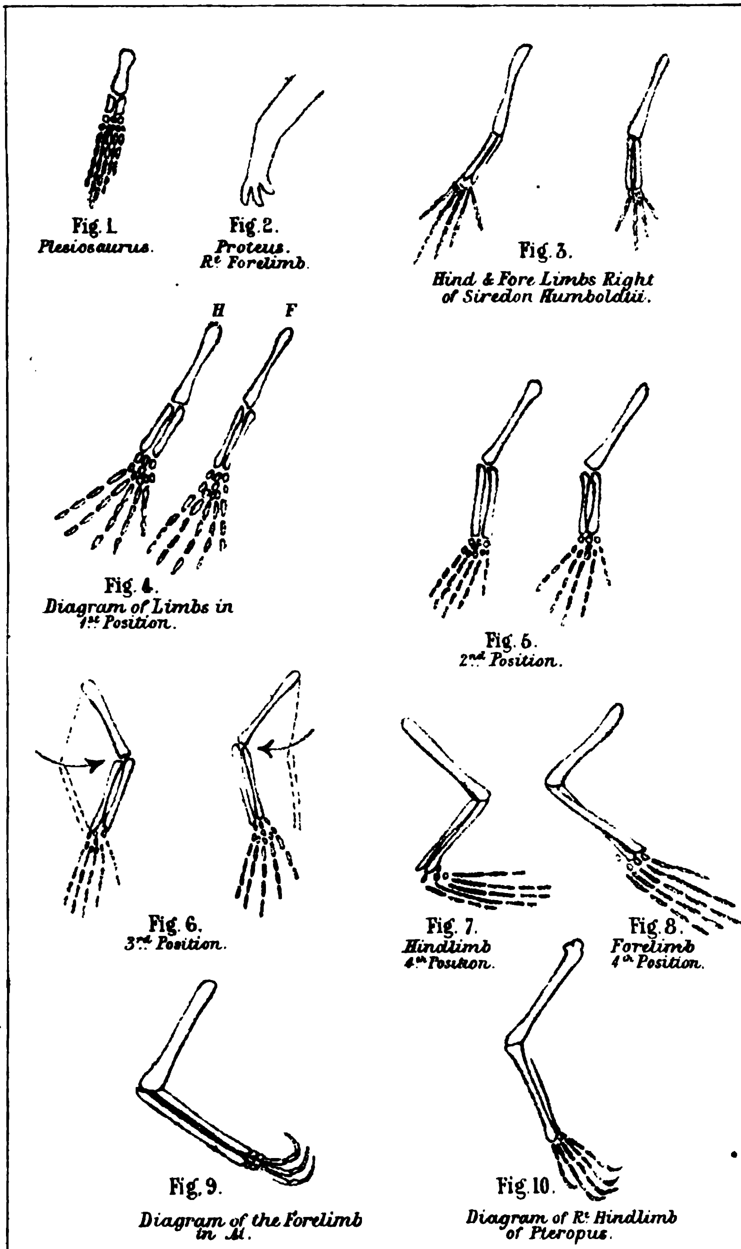


Fig. 1. *Plesiosaurus.*

Fig. 2. *Proteus. Rt Forelimb.*

Fig. 3. *Hind & Fore Limbs Right of Siredon Humboldtii.*

Fig. 4. *Diagram of Limbs in 1st Position.*

Fig. 5. *2nd Position.*

Fig. 6. *3rd Position.*

Fig. 7. *Hindlimb 4th Position.*

Fig. 8. *Forelimb 4th Position.*

Fig. 9. *Diagram of the Forelimb in M.*

Fig. 10. *Diagram of Rt Hindlimb of Pteropus.*

Forster & Co. Dublin.

Cypripedium Caudatum.

Forster & C° Dublin

[XL1]

Vol. VI.—No. II.] [Price 2s.

THE JOURNAL

OF THE

ROYAL DUBLIN SOCIETY.

CONTENTS:

		PAGE.
1.	Professor Ball on Energy,	187
2.	Dr. Reynolds on Coal Gas and its Flame,	189
3.	Mr. Wigham on Gas for Lighthouse Illumination,	192
4.	Mr. Kirby on the Species of Saturnidæ, or Ocellated Silkworm Moths,	201
5.	Dr. Barry on Cotton-growing in Fiji, with some Remarks on the Country and its Inhabitants,	205
6.	Dr. Reynolds—Outline of a New Explanation of the Action of Sunlight on Iodide of Silver,	210
7.	Major Collins on a New Angle-Measurer and Protractor, for facilitating the Processes of Field Sketching and Surveying,	215
8.	Mr. Hull's Notes on the Hæmatites of Counties of Cavan and Longford,	217
9.	Return of Donations to the Royal Dublin Society,	219
10.	Intelligence:—	
	School of Art,	229
	Spring Cattle Show, 1872,	345
	Evening Meetings,	352
	Letter of Professor Reynolds, and Report on the Utilization of Peat,	355
	Appendix—Meteorological Journal from 1st June, 1871, to 28th September, 1872,	i

DUBLIN:

HODGES, FOSTER, AND CO., 104, GRAFTON-STREET,

BOOKSELLERS TO THE ROYAL DUBLIN SOCIETY.

LONDON: SIMPKIN, MARSHALL, AND CO. EDINBURGH: JOHN MENZIES AND CO.

1872

The Society

Royal Dublin Society.

FOUNDED 1731. INCORPORATED 1749.

THE Society consists of Members, who, on being proposed and seconded, are elected at the next Meeting by Ballot, previously to which the Fees, as follows, must be lodged with the Treasurer:—

Life Membership, ...£21 0 0

Annual Membership (with £3 3s. Entrance Fee), 2 2 0

Annual Subscriptions due on 1st January. Persons in arrear on the 1st April cease to be Members.

Annual Members may at any time become Life Members upon payment of £15 15s., £10 10s., or £5 5s., according to standing.

I.—Meetings of the Society and the Council.

1. *Stated and Ordinary Meetings.*

The Society meets at 3 o'Clock P. M., pursuant to the Charter, on the second Thursday in November, and the First Thursday in March and June.

The Council meets during the Session at Three o'Clock on every Thursday not occupied by the Meetings of the Society.

2. *Evening Scientific Meetings.*

Meetings of the Society, for the reading and discussion of Papers on Scientific subjects, are held on the third Monday in each Month during the Session.

Persons desirous to read Communications must submit their Papers to the Committee a week, at least, previously, for examination and approval.

The Copyright of all Papers read becomes the property of the Society; and such as are considered suitable for the purpose will be published in the Journal of the Society.

Except under special circumstances, no person can be permitted to occupy the Meeting in reading a Paper for a longer period than half-an-hour; and the Society will not be held responsible for any opinions advocated in the communications read.

Each Subscriber of 5s. to the Refreshment Fund is entitled to Tickets, to admit Visitors, at 6*d*. each; or to twelve for 5*s*., available for any of the ordinary Meetings throughout the Session.

The Standing Committees.

Six Standing Committees are annually elected, as follows:—1. Agriculture; 2. Botany; 3. Fine Arts; 4. Library; 5. Natural History; 6. Practical Science.

[*For continuation, see page* 3 *of Cover.*

THE JOURNAL

OF THE

ROYAL DUBLIN SOCIETY.

XVII.—*On Energy.* By ROBERT STAWELL BALL, A. M., LL.D., Professor of Applied Mathematics and Mechanism, Royal College of Science for Ireland: being the substance of a Discourse delivered on Monday evening, December 18, 1871.

INTRODUCTION.

THE science of Energy has been developed within the last twenty-five years, and appears to have a grand future, as intimately connected with astronomy, mechanics, light, heat, magnetism, electricity, even with life itself—leads us back through periods compared with which geological time is as nothing, and, like a time telescope, points out the ultimate destiny of the universe.

Energy.

Energy is the capacity for raising weights. Distinction between Force and Energy: Energy is the product of a force and a distance; the unit of energy is the energy required to overcome the unit of force through the unit of distance. Energy can be stored in a rapidly moving fly-wheel. This is demonstrated by experiment. Energy is also stored in any body moving rapidly; for example, a cannon ball. Energy of this kind is termed kinetic energy. A steam engine is a means of turning into mechanical work a portion of the energy contained in the coal consumed in the furnace. Heat may be turned into mechanical work in other ways; for example, by a thermo-electric battery. The energy stored up in coal is denominated potential energy; gunpowder, and a compressed spring, are other forms of potential energy. Food and fuel are both forms of potential energy; but the former has to replace the wear and tear of the machine which consumes it, which the latter has not. Energy can be changed from one form into another. The potential energy of the body may be turned into mechanical work by raising a weight, into kinetic energy by setting a wheel in motion,

into heat by friction, into electricity, heat, and light, by Wilde's electric machine. A piece of zinc may be burned in a stream of oxygen. The potential energy is turned into light and heat, but the zinc might be burned slowly in a battery; it would then develope electricity, which may be turned into kinetic energy by an electro-magnetic engine, or into light, sound, and heat, by a Ruhmkorff's coil.

Indestructibility of Energy.

If energy disappears in one form, it reappears in another. A hammered nail on an anvil becomes hot; the energy which moves the hammer is transformed into heat in the nail; it is not lost. Friction appears to consume energy, but heat is produced sufficient to boil ether or water when properly applied. The kinetic energy of a rotating toothed-wheel can be transformed into sound by Savart's apparatus.

Energy cannot be created.

Perpetual motion is impossible, because some energy is always uselessly expended in friction in every machine, and energy cannot be created. A water wheel could not pump up sufficient water to supply itself. It has been (fallaciously) proposed to work a magneto-electric machine by a steam engine; to decompose water with the electricity, and sustain the action of the steam engine by the heat developed by burning the oxygen and hydrogen produced by the decomposition. The steam engine could not decompose enough water for the purpose. Since energy cannot be destroyed and cannot be created, the quantity of energy in the universe must remain constant; this is the principle of the conservation of energy.

The Distribution of Energy throughout the Universe.

The different forms of Energy on the earth, whether derived from food, fuel, wind, or water, can be traced to the heat radiated from the sun. The heat is sustained in the sun by the transformation of potential energy into heat due to the sun's contraction. If the diameter of the sun diminished $\frac{1}{10000}$ part, heat sufficient to supply the present loss by radiation for 2000 years would be produced. The heat of the stars represents a prodigious quantity of energy. The earth has a store of potential energy due to its distance from the sun. This energy is equivalent to as much heat as would be produced by the combustion of 6000 globes of coal each as large as the earth. The earth also has an amount of energy due to its velocity in its orbit equal to that which would be produced by the combustion of 14 globes of coal of its own size. To this must be added a quantity of energy due to the rotation of the earth on its axis.

The Dissipation of Energy.

The planets, since they are not rigid bodies, must ultimately fall into the sun. Heat diffuses itself, but heat cannot be turned into mechanical energy unless when transferred from a hot body to a cold body. When, therefore, by the diffusion of heat, the temperature is uniform throughout the universe, mechanical work must cease.

XVIII.—*Coal Gas and its Flame.* Notes of a Discourse delivered by Dr. J. EMERSON REYNOLDS, Professor of Analytical Chemistry, and Keeper of the Minerals, R. D. S., February 19, 1872.

THE Lecturer began by remarking that we are all familiar with the fact, that a particular theory may long continue to be accepted by the scientific and general public; but in time it may happen to be put to more severe tests than before, and will then generally have to give place to some other theory more in accordance with our advancing knowledge. This is at present the case with the theory of the luminosity of gas and other flames. About 1817, Sir Humphrey Davy promulgated his theory of the luminosity of flame, which has been accepted almost without question up to within three or four years ago. At that time Professor Frankland attacked Sir Humphrey Davy's theory, and attempted to show that it was, if not untenable, at least incapable of accounting fully for the luminosity of flame. The Lecturer proposed now to give as short and complete a statement as possible of the respective views of Davy and Frankland on the cause of luminosity of flame in general, and of that of coal gas in particular. Before doing so, however, it seemed desirable to briefly sketch the chemistry of coal gas, in so far as necessary for the object in view.

Gas is produced by a peculiar mode of distillation of common coal. When coal is subjected to a moderate degree of heat, various bodies, solid, liquid, and gaseous are produced. The solid bodies need not be noticed, and the liquid products require no special reference at present. We may therefore turn chiefly to the gaseous bodies. A mere list of the volatile constituents of coal would be very lengthy; but it is sufficient now to consider only the combustible bodies, which may be naturally divided into two classes. The first class consists of bodies which in burning emit very little light; and the second consists of highly luminous bodies.

Among the comparatively little luminous bodies are hydrogen, carbonic oxide, bisulphide of carbon, and marsh gas; the principal bodies capable of burning with a luminous flame are olefiant gas, acetylene, butylene, propylene, &c., and vapours of various other hydrocarbons. The flame of hydrogen is very feebly luminous; but of olefiant gas is highly luminous; we can, however, render the flame of

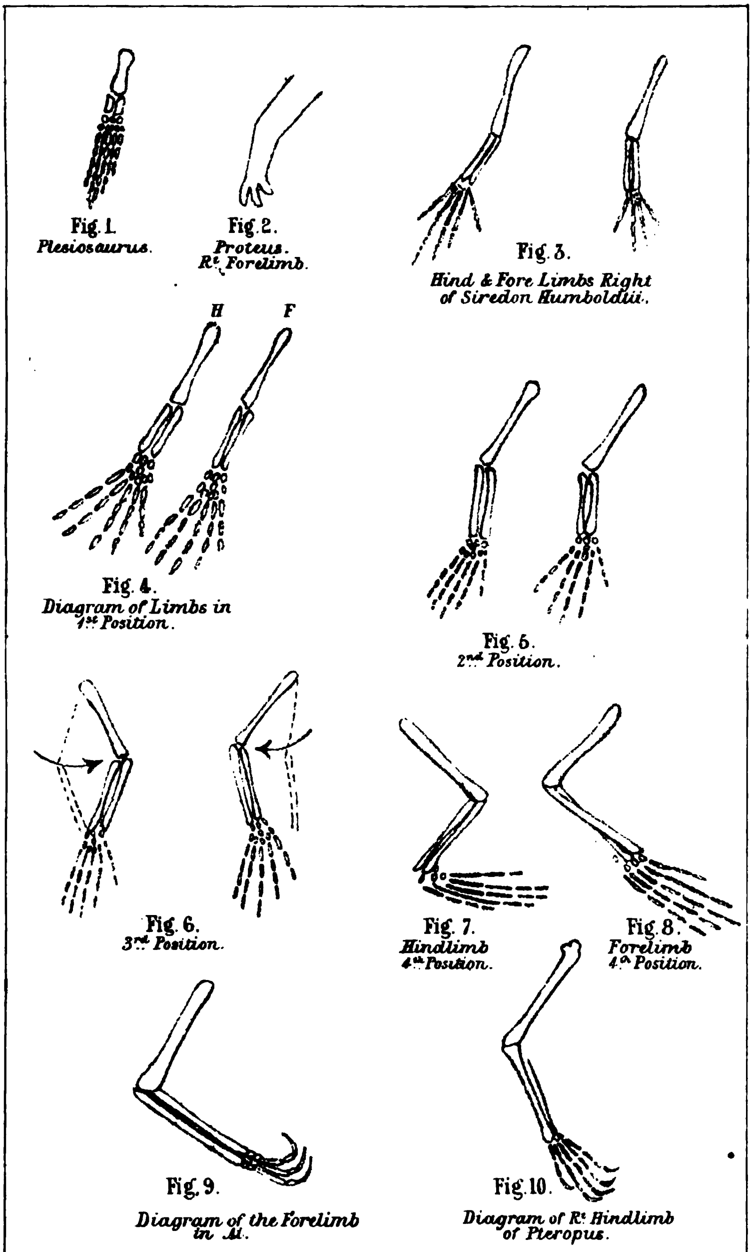


Fig. 1. *Plesiosaurus.*

Fig. 2. *Proteus.* *Rt. Forelimb.*

Fig. 3. *Hind & Fore Limbs Right of Siredon Humboldtii.*

Fig. 4. *Diagram of Limbs in 1st Position.*

Fig. 5. *2nd Position.*

Fig. 6. *3rd Position.*

Fig. 7. *Hindlimb 4th Position.*

Fig. 8. *Forelimb 4th Position.*

Fig. 9. *Diagram of the Forelimb in Ai.*

Fig. 10. *Diagram of Rt. Hindlimb of Pteropus.*

Forster & Co. Dublin.

Cypripedium Caudatum.

Forster & Co. Dublin

which the gas is saved until the flame is again raised; whereas, in the case of an oil lamp, it must burn at its full flame, whether the light is eclipsed or not.

Perhaps I may be permitted to say a few words upon the general subject of gas for lighthouses, before describing the latest improvements in the mode of burning it. A flame obtained from gas, by the method I have described, possesses, in an eminent degree, both quantity and intensity. It is unnecessary to say that the former quality is of great importance in lighthouse illumination. Every one knows that the lime light and the electric light, while possessing exceeding intensity, are deficient in quantity, and we are all familiar with the deep darkness to be found outside the line of the rays thrown out by these lights. This want of divergence is a serious drawback to the usefulness of such lights, as it necessitates exceeding accuracy of adjustment in the necessary lenticular apparatus. No doubt lenses could be, and have been constructed for making such flames more divergent, but the peculiar characteristic of the light is then, to a large extent, lost. Dr. Barnard, President of Columbia College, New York, informed me, that from his investigation of a series of experiments made in France with the newest and most powerful forms of the electric light, he had formed an opinion that the rays from gas-light would be found more efficacious in penetrating fogs than even those of the electric light, magnificent and intense as they admittedly are; and this he considered chiefly due to the colour of the electric light. One manifest advantage possessed by the gas over the electric light is the greater simplicity and much smaller cost of the apparatus required for its generation, and the great ease and certainty with which gas can be made, and its light maintained. The simplicity of the gas apparatus is such that any ordinary labourer can manage it; but in the case of the electric light, skilled labour is required to superintend the electro-magnetic machines, from which the electricity is produced, and the steam engines by which these machines are driven. To guard against any break down in the electric light, duplicate steam boilers, duplicate engines, duplicate electrical machinery, and duplicate electric lamps are provided, and all this is not only very complicated, but enormously more costly than the most perfect gas apparatus. It has been urged against the use of gas, that its supply may be uncertain, and liable to interruption from failure of the apparatus by which it is made, &c.; but the fact, that it has been used at two lighthouses for about *six* years, without any intermission whatever, is a sufficient answer to that objection. Besides which, the apparatus for gas in lighthouses is so arranged that in two or three minutes the light may be changed from gas to oil, and thus any serious consequence from a failure of the gas-light (should such ever occur) is provided against; but as just stated, no occasion for using this provision has arisen during the time above mentioned.* The gas flame being as *large* as that of the oil lamp,

* A mercury lute is so placed that at any time the ordinary oil lamp may very quickly be substituted for the gas lamp.

no alteration of the lenticular apparatus is necessary in the event of this temporary change being made; and this is another advantage which gas possesses, and which is not to be found in the electric light; for an oil lamp placed in the focus of the lense with which the electric light is generally used, would be ex-focal, and give comparatively little light.

A few months previous to his lamented death, Captain Roberts expressed a desire to obtain a still more powerful gas-light than that at Howth Bailey Lighthouse, and I therefore designed a new form of burner, from which a greatly increased amount of light could be obtained. It consists of rings of gas-jets, which can be lighted or cut off according to the requirements of the weather, and this burner strikingly exemplifies one of the most important advantages of gas for lighthouses—advantages not possessed by the flames of oil lamps or paraffin lamps; that gas-light can be burned in almost endless degrees of intensity; and that these different degrees are capable of rapid alteration, to suit the state of the atmosphere in fog or snow-storm, or to act as signals, should such be required.

Double jets, by which a more effective combustion of gas is attained, with less consumption for each jet than in the original crocus burner, are made use of in this new burner. The principle of the double jet is not new, but I believe that the present form of its application is entirely so. It is exceedingly simple, and may be explained by this ordinary gas burner. . . .

By the arrangement just explained, a much larger amount of light is obtained from a given quantity of gas, than by using ordinary single jets, and the gas is burned in a manner peculiarly suited to the fundamental principle of the crocus burner, which, as I have before stated, is the utilization of the smoky particles of carbon in the upper part of the flame. This burner was applied at Howth Bailey Lighthouse in 1869, and its good effects were so manifest that, at the request of the Board of Irish Lights, the Board of Trade sent over Dr. Tyndall, F.R. S., of the Royal Institution, London, to make a report concerning it. He visited Ireland in June of the same year, and made many Photometric and other experiments. In this report he thus describes the burner: "The gas burner devised and constructed by Mr. Wigham consists of a series of concentric fish-tail jets. The three central rings embrace a group of 28 jets, and this is the light employed under ordinary circumstances at Howth Bailey. To this central group can be added in succession four other circles of burners, each embracing 20 jets. Thus the lowest light employed is emitted by 28 jets, the next in power by 48, the next by 68, the next by 88, and the next by 108 jets of gas. It is possible, therefore, to employ lights of five different powers."

Dr. Tyndall goes on to say that the photometric superiority of the gas over the oil flame is rendered very conspicuous by the experiments which were made. With regard to this superiority of gas over oil, it is to be observed that the peculiar form of lenticular apparatus used in lighthouses places the larger gas flames at some disadvantage, for much of the light is exfocal, and thus to

a considerable extent wasted. Were dioptric apparatus constructed to suit the large size of the gas flame, a much more splendid result than even that already attained would be arrived at. Respecting the peculiar advantages of gas in enabling a higher power of light to be used during thick weather, Dr. Tyndall says: "Besides the advantage of greater cheapness, the great increase of illuminating power which the employment of gas places at the disposal of the lighthouse keeper on foggy nights is a consideration of the *very highest importance.*" One of these burners is on the table for your inspection.

An important peculiarity of the gas system for lighthouses is, that the gas burner while lighted is nearly quite independent of all care on the part of the light-keeper, and cannot, except intentionally, be burned so as to give *less* than its proper focal size of flame. The oil lamp, on the contrary, requires continual watchfulness; and although a careful light-keeper will endeavour to keep its flame at full focal height, yet there is no doubt that it requires constant skill and attention to do so, and that sometimes a proper light is *not* maintained. Another peculiarity of the gas light is, that when it is desirable to extinguish and relight its flame for any purpose, as in the case of intermittent lights, or when additional power for penetrating fogs is required, the changes can be effected in a moment. This cannot be done satisfactorily with oil or paraffin lamps, for any manipulation of the wicks causes incrustations of carbon upon them, irregularity of flame, smoke, and consequent loss of light. The gas system has also the great collateral advantage that a supply of gas at a lighthouse is a motive power always at hand by which at a few minutes' notice fog trumpets or whistles may be sounded. This has been availed of at Howth Bailey Lighthouse, where gas has been employed to drive a Hugon's patent gas engine, which requires only the application of a match to set it in motion. Many other interesting experiments have been made at that lighthouse with gas as a means for fog signalling. An engine for compressing air, and thus sounding an enormous trumpet, was driven by gas, and quite recently *guns* charged with, and fired by gas, have been tried with good effect.

I have now to make a few observations on the mode in which gaslight is applied to the lenticular apparatus used for revolving lights. As I have before indicated, great economy results from the employment of gas for intermittent lights; for, if the light be intermitted with equal periods of darkness, for example, that there are three seconds of light, and three seconds of darkness, it is evident that about one-half the quantity of gas which would otherwise be used will be saved. This is an economy of no small moment to lighthouse authorities, and therefore it was, that very soon after the first introduction of gas for lighthouse purposes the gentleman whose name I have already mentioned (Mr. Bewley) placed before me the problem of adapting this great advantage of gas light to *revolving* lights, as well as those of an *intermittent* character. This problem I did not find easy of solution, and it is only very

recently that the investigations and experiments with regard to it have been completed.

That the difficulty appeared considerable may be inferred from the fact that Messrs. Stevenson, the well-known engineers to the Board of Northern Lighthouses, not only declared against the use of gas for revolving lights, but officially reported to that effect to their Board, by whom their report was forwarded to the Board of Trade. I was not discouraged by this, as from the outset Messrs. Stevenson had opposed the use of gas, even for fixed lights, but I was positively told that the thing was *impossible*, and that I would do well to confine my attention to the improvement of the light itself, and not to attempt to pry into the mysteries of annular lenses and cylindric refracting belts. In short, I was strongly advised to mind my own business, and I determined to accept the advice; for I had resolved to make it my *especial* business to attempt the solution of this question. The measure of success which has attended my efforts I shall now very briefly proceed to show. First let me say a word about the catoptric or reflector system of revolving lights. The members of this Society can very readily understand that a mechanical arrangement not difficult to devise would admit of the use of gas for a series of revolving reflectors; a ground-in gas joint fed from a central source, and having radial arms to convey the gas to the reflectors, would admit of its being burned in the focus of each reflector with perfect steadiness even while the revolution of the reflectors was such as to cause each of them in rotation to present its face to every part of the horizon. In the case of dioptric apparatus in which there is but one light instead of many, as in the catoptric system, and in which the light is stationary and the lenses revolve, having the burner for a common focus, it will be seen that there is also no difficulty; the gas lamp has only to be substituted for the oil lamp at present used; but the question was how to render available for revolving lights the facility with which gas can be periodically extinguished and economised, as in the case of intermittent lights. I was told that the most eminent opticians and engineers, in their investigations respecting revolving lights, having by the most careful and complete calculations determined the precise form of apparatus by which the utmost possible amount of light would be transmitted to the observer, and having so arranged and planned the apparatus that not one particle of that light would be wasted, but would be *all* so transmitted, it logically followed that the *whole* being utilized, it was impossible to save any *part* without injury to the mariner. Before proceeding to discuss this objection, it may be well to explain, by means of the annular lens for revolving lights, and the refracting belt for fixed and intermittent lights, which we have here, the precise difference between them. The refracting belt is cylindric in form; what we have here is a segment of a circle of about six feet in diameter . . . . The light is central, and its rays are transmitted *horizontally*, but equally, to every part of the horizon. By lighting the gas behind the belt you may readily see this. . . . .

This annular lens, ... of which eight are generally used for revolving lights, not only transmits the whole of the rays horizontally, but also collects them into one parrallel beam. It will be evident, therefore, that the power of the annular lens is greatly superior to that of the refracting belt; it has been ascertained by calculation to be thirteen times more powerful. By lighting the gas you may judge of this . . . That the enormously greater power possessed by annular lenses can only be availed of in revolving lights is obvious; for the fact of the horizontal rays being parallelized of necessity causes angles of darkness, and to give light to those dark portions of the horizon it is necessary to cause the octagon of lenses to revolve so that the beam from each lens may traverse the whole horizon thus . . . . This rough

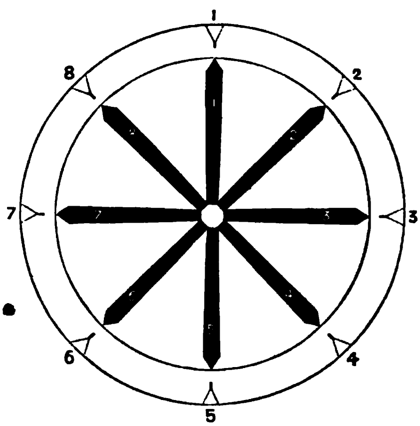


diagram . . . represents the whole octagon of which the lens we have here is one side. The dark rays are intended to show approximately the manner in which the beams of light are transmitted to the horizon. Eight portions of the horizon are illuminated by these beams, but you will observe that the eight portions between them (and which are of much greater extent) are in darkness, due to the angle of which we have been speaking . . . . I think by means of this diagram you will readily see how we can take advantage of the economy of intermittent gas flashes for revolving lights without depriving the mariner of any light. *We simply make use of the periods of darkness.* Thus, suppose the apparatus set in motion, beam No. 1, now lighting a point of the horizon marked No. 1, will move on till it occupies the place now held by beam No. 2. Beam No. 2 will replace beam No. 3. Beam No. 3 will replace No. 4, No. 4 will replace No. 5, and so on, beam No. 8 replacing beam No. 1. Thus every part of the horizon will have been visited by a beam or flash of light, and if the complete revolution of the octagon of lenses occupies, say ninety-six seconds, a beam or flash of light will reach an observer stationed at any point of the horizon every twelve seconds; but if, when beam No. 1 reaches the place occupied by beam No. 2, the revolving machinery is stopped and remains stationary for twelve seconds, during which time the gas is extinguished and not relighted till the machine is again set in motion, it is evident that the observer will receive a flash every twenty-four seconds instead of every twelve seconds. As, however, it is not convenient to stop the revolution of the octagon of lenses, which is very heavy and could not

soon regain its proper velocity, we can accomplish the same end without stopping the machinery, by extinguishing the gas at the moment when the whole horizon has been illuminated, and not relighting it till the lapse of the same period of time as was occupied in that illumination: thus, say an observer at point No. 4 on the horizon has received a flash from the lens of beam No. 4; beam No. 3 is coming on, and under ordinary circumstances he would receive a flash from it; but the moment the light reaches him (perhaps showing him a momentary glimmer) the gas is lowered, and not raised again till lens No. 2 is opposite to him, when he receives the flash exactly twelve seconds later than he would otherwise have received it. Thus, in the case we have been supposing, every alternate lens passes over one-eighth of the whole horizon in the dark, and the same effect is produced as if the machine were stopped. Rockabill is an example of a lighthouse, the flash from which reaches any given point on the horizon every twelve seconds. The adoption of such a plan as we have just been considering would alter the flash to twenty-four seconds, which is rapid enough for all maritime purposes, even one minute flashes being considered sufficiently frequent. It is clear, therefore, that one-half the consumption of gas in revolving lights would be saved by this plan of simply doubling the duration of each period of darkness. The Board of Trade considered the matter so important that they again requested Dr. Tyndall to investigate it. His report, which has been printed and laid before Parliament, speaks favourably of the use of gas for revolving lights. He also makes special reference to another form of its application which shortly before his visit I had, with the kind assistance of Captain Hawes, R. N., Inspector of Irish Lights, devised and designated the "group flashing light." I had also had the privilege of exhibiting my first experiments with this light to Mr. Howard Grubb, well known to us all as a distinguished member of this Society, and obtaining his favourable opinion respecting it. It may be briefly described as a continual intermittent light in conjunction with revolving annular lenses. Instead of extinguishing the gas light during the passage of every alternate lens, as just described, a little piece of wheel work connected with the machinery which causes the lenses to revolve is so arranged that the gas light is continuously lowered, and raised again, without interruption to the ordinary revolution of the lens. This, of course, can be roughly done by hand thus . . . . The saving of the cost of gas by this means is as great as by the other; for if there be equal periods of light and darkness—say one second of each—it is evident one-half the consumption of gas will be saved. This method has this great advantage, that the continual extinction and re-exhibition of the light causes an effect upon the eye which is highly approved by mariners, from the remarkable way in which it arrests attention, especially in thick weather. The name "group" is applied to this light, because, as you have just seen, instead of *one* flash, a group of six or eight flashes reaches the eye at each recurring period. The required duration of the individual flashes

composing each group is obtained by regulating the revolution of the lenticular apparatus to the necessary speed. I may also observe that the duration of these flashes may be prolonged by the use of gas flames of more than ordinary diameter. A convenient interval between the centre of one group and the centre of the next is one minute. It may be interesting to the members of this Society to know that the importance of this new form of light has been so fully recognised by the Board of Trade, that they have sanctioned the erection of gas at Rockabill Lighthouse for the supply of gas to the annular lens revolving apparatus there, and for practically testing the new system by further trials and experiments. As it is probably new to some of the members of this Society, perhaps I may be allowed to read a short extract from Dr. Tyndall's report of the recent experiments which have been made, and his conclusions respecting them.

"With respect to the group light" he says, "'a powerful and indeed splendid effect' are the words employed in my notes to describe this light, * * * * and should it be thought desirable to give a revolving light so destinctive a character as to render it perfectly unmistakeable, the group flashing gas light, as its inventor Mr. Wigham calls it, secures this end. I have not been called upon to offer any recommendation as to its adoption, and would, therefore, merely refer to it as a light of unrivalled individuality, of great power, and in Ireland at least of moderate cost." On the general subject of Gas for Lighthouses, Dr. Tyndall adds:— "During my recent visit I also made experiments on the flashing of the fixed light at Howth Bailey. The results assure me that, with gas as a source of illumination, an amount of variableness, and consequent distinctiveness, is attainable, which is not attainable with any kind of oil. It would, I think, be easy to give to every lighthouse supplied by gas so marked a character that a mariner, on nearing the light, should know with infallible certainty its name. As stated in a former report, I look, in great part, to the 'flexibility' with which gas lends itself to the purposes of a signal light for its future usefulness. It may be beaten in the point of cheapness by the mineral oils now coming into use (that is still to be proved); but in point of handiness, distinctiveness, and power of variability to meet the changes of the weather, it will maintain its superiority over all oils. I therefore respectfully submit to the Board of Trade, that, while withholding all countenance from extravagant or fanciful experiments, it will be wise to encourage, as hitherto, the gradual, economical, and consequent healthy expansion of the system of gas illumination in Ireland."

An opinion so decided, emanating from so high an authority possesses much weight. Dr. Tyndall has given particular attention to this subject. He has visited Ireland four times to investigate it, and therefore the Board of Irish Lights have considered it their duty, on the receipt of his reports from time to time, to continue their efforts for the development of the system of the use of gas for lighthouses. Hence by their orders five first order lighthouses have now been lighted by gas in Ireland. Howth Bailey, Wicklow Head, Hook Tower, Mine Head, and Rockabill.

The Trinity house, also, are applying gas to one, if not both of the lighthouses at Haisboro, on the coast of Norfolk, under the superintendence of their eminent engineer-in-chief, Mr. James N. Douglass, C. E.

The system of the illumination of lighthouses by gas having been thus put into practical operation, its advantages are becoming every day more apparent. It is steadily gaining favour with those most competent to form an opinion respecting its merits, and lighthouse authorities are too keenly alive to all that concerns the welfare of the mariner to overlook the benefits to navigation which are presented by it. Ordinary oil lamps or paraffin lamps are sufficient in clear weather to transmit light to the horizon, but the *sailor* anxiously desires a light having the power to penetrate a dense foggy atmosphere. Gas possesses this power in a degree pre-eminently superior to all other lights (the electric light perhaps excepted), and as its economy and convenience have been already so clearly demonstrated, it is not unreasonable to anticipate its very general adoption.

In conclusion, I desire to take this opportunity publicly to acknowledge my obligations to the Board of Irish Lights, for it is only due to that Board to say, that but for the interest they have taken in this question, and the facilities which they have always most courteously afforded me, the system of the illumination of lighthouses by gas would not have advanced to its present position. I desire also to express my sense of the promptness and liberality with which the Board of Trade, and The Elder Brethren of the Trinity House, when the subject was clearly explained to them, gave their sanction and encouragement to the practical application of the system, and I consider that all interested in navigation and maritime commerce owe a debt of gratitude to these Boards and their officers, and to Dr. Tyndall, for the careful attention they have given to this subject, and the effectual steps they have taken to secure for the guidance and safety of the mariner the advantages which are found in the powerful flames of gas for lighthouse illumination.

XX.—*Notes on the Species of Saturnidæ, or Ocellated Silkworm Moths, in the Collection of the Royal Dublin Society.* By W. F. Kirby, Assistant in the Museum.

[Read March 18, 1872].

Although the Society's collection is very poor in these insects, yet their large size and economic importance render them peculiarly interesting; and the recent acquisition of several additional specimens and species, through the liberality of Mrs. Battersby, of Cromlyn, Rathowen, Westmeath; and Mr. W. V. Andrews, of New York, has decided me to bring the group under the notice of the Society this evening. Very little has been published lately on the domestication of silkworms; and I have nothing new to bring forward in that direction but a few observations compiled from private sources.

Attacus Hesperus, Linn. Trinidad.

Attacus Atlas, Linn. East Indies.

This common and well-known insect is the largest of all known *Lepidoptera*, very few approaching it in breadth or expanse of wing.

Attacus Cynthia, Dru. East Indies; and Ireland (bred).

This is the species to which Drury's name is generally applied, but his figure differs so much from that of Cramer that I doubt whether the two authors have not figured different species. The Irish specimens were bred by myself. I am inclined to think that the climate of Ireland is too wet to allow either the Aïlanthus tree or the silkworm to thrive properly. The tree does not flourish in Ireland nearly so well as in England; and I was not able to obtain fertile eggs from my silkworms, and therefore failed in perpetuating the brood, though I am quite prepared to expect that continued trials might be more successful. Last autumn I received a letter from one of my brothers who was then living near Northampton. Noticing some Aïlanthus trees in a garden in the middle of the town, he made some inquiries of the gentleman to whom they belonged. The trees had been planted about four years, and were about fifteen feet high. The cocoons are kept in the cellar all winter, in the coldest and dryest place to be found; when the trees come into leaf, the moths are hatched (I suppose by exposing the cocoons to a moderate temperature), and the worms are turned loose on the trees. They require no protection or looking after whatever, as they keep on the under side of the leaves, and are thus protected from the rain and birds, and but very few are lost in a season—scarcely half a dozen. When they spin, the cocoons are taken of the trees, and stowed away till next season.

Samia Cecropia, Linn. North America.

Grote has changed the generic name *Samia* (used by Walker) without sufficient reason, applying it to *Attacus Cynthia*. Although Abbot states that the silk of this species had been carded, spun, and made into stockings which would wash like linen, I am not aware that any recent experiments have been made on it. Abbot's book on the Lepidoptera of Georgia was published in 1797. He says the species is rare in that part of America, though commoner in the North.

Samia Cecropia, var. Nova Scotia.

The submarginal black band of the hind wings is much broader than in the typical insect.

Samia Californica, Grote. Vancouver's Island.

Callosamia Promethea, Dru. North America.

C. Angulifera, Walk. North America.

The figure given by Hübner of *Promethea* is somewhat intermediate in appearance between the two species.

Telea Paphia, Linn. North America.

It has, I think, been questioned whether Cramer's *Attacus Polyphemus* from Jamaica is identical with this common species.

Telea Paphia, var. Nova Scotia, differs from the type in its smaller size, the broader bluish-black band of the hind wings, and the very distinct markings of the under surface of the wings.

Antheræa Mylitta, Dru. India.

This is the Tusseh silkworm moth, and has hitherto been frequently considered to be the true *Attacus Paphia*, L. A long and interesting account of this species is given in Horsfield and Moore's Catalogue of the Lepidopterous Insects of the East India Museum, pp. 385–396. Great quantities of silk are procured by the Hindoos from this species, which is only semi-domesticated. It is somewhat variable.

A. Helferi, Moore. India.
A. Simla, Westw. N. India.
A. Helena, White. } Australia.
A. Astrophela, Walk. }

A. Pernyi, Guer.

This is the oak-feeding silkworm of North China. Walker considers it a variety of the Tusseb silkworm moth (*Anthera Mylitta*) mentioned above; and although *A. Pernyi* and *A. Yama-maï* differ from each other as well as from *A. Mylitta* very considerably, yet as the two former have been domesticated for many generations, it is far from impossible that they may be local forms of the common Indian species. I am not sure that they are met with at all in a wild state; and although hybrids are easily reared, I cannot say whether they are fertile *inter se*. If so, there can be no question as to the specific identity of the three forms, considering the great amount of variability exhibited by almost every animal which is subjected to domestication.

A. Yama-maï, Guer.

The Japanese oak-feeding silkworm, which has frequently been brought under the Society's notice already. Mrs. Battersby, to whom we are indebted for a fine series of this species and the last, as well as of their cocoons, states that the larvæ resemble each other greatly; but in consequence of the constant difference in the cocoons, she is disposed to consider them distinct species. It may be observed, however, that the common silkworm (*Bombyx mori*) differs considerably in the colour of its cocoon, some races having white, and others yellow cocoons.

Mrs. Battersby writes, respecting *A. Yama-maï*: "We have a large number of young oaks in our lawn; I always feed them from the same tree, but indoors. I think Mr. Wallace wets the leaves and young larvæ far too much when they first emerge." She remarks further, that the breed seems to have degenerated with her, as she does not rear nearly such fine specimens now as she used to when she first commenced, three or four years ago. I believe that some of the most successful English breeders of *A. Yama-maï* agree with Mrs. Battersby, that moisture is not only unnecessary but even injurious to the larvæ.

Lœpa Katinka, Westw. India.
Actias Luna, Linn. N. America.
A. Campionea, Sign. S. Africa.
A. Selene, Leach. East Indies.
A. Leto, Doubl. India.

This genus is principally remarkable for the long tails to the hind wings. Very few species are known, one of which is Spanish. If the genus was larger, no doubt it would be divided into several, as the species differ very much in shape.

Saturnia Pavonia-major, Linn. Europe.

This species, which ought perhaps to be regarded as the true type of the genus *Attacus*, is the largest Lepidopterous insect found in Europe. It is very common in some places, the larva feeding on fruit-trees. A friend once gave me a specimen which he reared at Paris from a larva feeding on apricot.

Saturnia Pavonia-minor, Linn. Europe.

This is the only British species of the family *Saturnidæ*. The sexes differ considerably; but another species (*S. Spini*, Den. and Schiff.) is found on the Continent, in which both sexes are coloured like the female of our common Emperor Moth. The larva of *S. Pavonia-minor* feeds on heath; and the cocoon is furnished with a kind of trap-door arrangement opening outwards, so that while all enemies are excluded, the moth can easily push its way out, and the cocoon closes behind it so completely, that it is impossible to ascertain by the closest ocular examination of the cocoon whether the insect has emerged from it or not.

Hyperchiria Io, Fabr. N. America.
H. Illustris, Walk. Brazil.
H. Irene, Cram. S. America.
Aglia Tau, Linn. Europe.
Dysdæmonia Boreas, Cram. Trinidad.
Micrattacus Nanus, Walk. S. America.
Eacles Imperialis, Dru. N. America.
E. Magnifica, Walk. Brazil.

XXI.—*Cotton growing in Fiji, with some Remarks on the Country and its Inhabitants.* By DR. JAMES M. BARRY.

[Read Monday, May 20, 1872.]

WHEN in Melbourne last year, the success attained by persons settling in Fiji, with a view to Cotton Culture, was brought prominently under my notice.

The notes then made form the basis of the paper which I this evening present for your consideration.

I may be excused mentioning that the Fiji or Viti Islands are a group of volcanic origin, situated in the South Pacific Ocean, between 15 and 20 S. Lat., and Long. 177 and 178 W. They were discovered by Tasman in 1643. There are upwards of 200 Islands, the principal Viti Levu, or Great Fiji, and Vanua Levu, or Great Land. Great Fiji has an area of about 90 miles by 50; population 50,000. Vanua Levu is 100 miles long by 30 broad; population 30,000. The temperature of the Island varies from about 60 to 120. In Levu are hot springs which range from 200 to 210. Earthquakes and hurricanes are periodical. The climate, for a tropical country, is healthy; dysentery is the most serious disease, prevalent during the wet season. December to March there is a troublesome form of inflammation of the eye, called Cica, distressing, but not dangerous to the sight. On the map, which I have had drawn on a large scale, the principal places to which I shall allude are coloured red. Levuka, where the Consular establishments are located, is situated in Ovulau, at the base of a lofty range of hills. The narrow strip of beach is occupied with stores and houses which are rapidly creeping up the valley. About a mile from the shore is a long line of coral reef, on which the ocean breaks with ceaseless roar. The hills in the back ground are densely covered with verdure; the graceful tree fern, banana, and cocoa-nut, and the curious screw pine are conspicuous.

In the town are three boat-building yards, which have turned out schooners up to 60 tons, as well as boats of all kinds required where the travelling and carriage are entirely by water. Levuka owes much of its commercial importance to a reef-locked harbour, accessible through deep broad passages in the coral. Around the shores of Ovulau in every little bay are native villages, sheltered by groves of cocoa-nut and bread-fruit. The well-kept Taro and Yarn plantations, the merry natives, and the beautiful scenery render Ovulau a very pleasant place to visit—but intercourse with white men is rapidly producing its effects. The natives are no longer content with a bit of tobacco and good "Sara sara" (look) at the white visitor in exchange for a cup of water or cocoa-nut milk; they now expect a shilling or more if they can extract it. On the coast the natives are Christians; the hill tribes, or Lavoni, are cannibals and heathens, the terror of the coast tribes, who are open to their

predatory excursions. Secure in the fastnesses of their mountains, they preserve a proud independence. There is a large half-caste town close to Levuka, the inhabitants of which are superior in intelligence to the Fiji men, on whom they look with great contempt. They have their own laws, magistrates and police. There are neither roads nor vehicles in Fiji. Horses recently introduced are employed in ploughing, and occasionally used for the saddle, in districts where there is no bush, but travelling is almost entirely carried on in boats which ply among the Islands. The charge for a good whale-boat, including crew, is 16s. per day.

A sail through these fertile Islands is extremely interesting; passing for instance through the Naitassi passage and leaving Mokagai in the rear, on which Mr. Hemmings has an extensive plantation, we approach numerous islets densely covered with cocoa-nuts, and clothed in all the rich luxuriance of tropical growth. To one of these islands King Cakobau sends his female convicts. He has also two peacocks which he values very highly for their rarity. The Vunivalu was one of the last to renounce cannibalism, which he treasured as the highest and exclusive privilege of his order. He has openly announced his conversion to Christianity, and gives his powerful influence to the missionaries to civilize and convert his people. His education has been thoroughly Fijian. At the age of five, a slave captured in battle was brought in and held down till the Boy King helped to club him to death. Cakobau is extremely temperate, and he finds his intercourse with the white men very profitable; he has been able to pay £1900 for a yacht, which he could not have dreamed of obtaining from his people two years ago. His palace is a large building; during its erection an enemy was killed, and buried under each of the posts; the walls are composed of reeds, and the roof of thatch, the whole put together with cocoa-nut fibre; no nails or any other kind of fastening being used in its construction; no windows, but many apertures, some larger for the use of chiefs; through the smaller ones slaves enter. These slaves are brought up in the most abject obedience to their chiefs, approaching them on their hands and knees, and never daring to stand in their presence. The interior of Cakobau's house is decorated with a double-barrelled fowling piece and a couple of swords; placed on the solitary table is a large Bible, and by its side a revolver, a glass candlestick, and a stereoscope; a large mirror in a broken frame is suggestive of the wrecking propensities for which the Fiji men are notorious. A likeness of the Princess Royal of England, and some coloured cuttings from the Illustrated London News, represent Arts.

Not far from the palace resides Cakobau's wife, Yadi Lydia; she is enormously fat, and in this respect comes up to the highest ideal of beauty, according to Fiji ideas. Her face is amiable, and she uses her great influence with the King in the cause of mercy, even in the old cannibal days, and is said to have saved many lives; Cakobau is usually dressed in a kilt made of the native *Tappa* (specimens of which manufacture are on the table). He, however, sometimes makes his appear-

ance in European clothing, when transacting business with white men. Cakobau is very proud of his canoes, and indeed they are wonderful specimens of naval architecture, about 80 feet long and 7 feet *hold;* they are capable of carrying 200 men. A smaller canoe is attached as an outrigger, and across the two is fixed the deck, on which stands a thatched house. These canoes are very swift, they carry a triangular sail made of matting. No vessel constructed by white men will sail so close to the wind. Not far from the church of Bau there stands the remains of an old heathen temple; a large stone on which the head of the victim was dashed to pieces, and a tree with innumerable notches, each notch representing a slaughtered captive, may still be seen on the ground; at the foot of the hill are five old carronades and some small casks said to contain gunpowder, but this I think very doubtful. It is now time for me to direct your attention to the most important subject connected with Fiji, at the present time, viz. the wonderful suitability of its soil and climate for the cultivation of cotton. When Mr. Seaman visited Fiji in 1860, cotton may be said to be almost unknown; Mr. Storcks, a botanist who accompanied him, brought cotton seeds of different kinds, which he sowed in a small plantation in the Island of Taviuni; subsequently he renewed his experiments on the banks of the Rewa, but unfortunately all the sea island seed was bad, and the first plantation consisted of the short-stapled description. In 1864 Mr. Burt purchased a small island 25 miles from the mouth of the river; here he planted cotton of the Egyptian variety, and gathered a crop of 550lbs. per acre; the island however became flooded, and he had to abandon the plantation. Notwithstanding the cannibal character of the natives living on this district, several planters were attracted to the locality, and recently more than 700 acres were under cultivation. The great difficulty the earlier settlers met with was, to induce the natives to sell their land; they were, however, ready to work for very small wages—something equivalent to 1s. per week, paid in knives, cotton-prints, hatchets &c.; on money they placed no value. The Rewa being a populous native district, labourers were abundant at times; but when most wanted, at the picking season, Fiji men were not always to be had, and the planters were obliged to resort to the New Hebrides for labourers, who were engaged for three years at about £3 per annum; as much as £12 passage money is sometimes paid to vessels for conveying these workmen. In 1864 Cakobau conquered the tribes for 60 miles up the river, and compelled them to Lotu, or adopt Christianity; this brought more land into the market. Being anxious to obtain fire-arms, the natives readily parted with the land at from 1*s.* 8*d.* to 5*s.* per acre. At present land in the possession of the settlers is worth £1. The first operation in preparing the ground for growing cotton is, to cut away the dense bush, which is done with knives some 14 inches long. The stumps of the trees are left standing. Women and children cara-cara, or clear the ground; this must be done between May and October. The cotton should be planted between October and the end of the year, before the rain sets in. The sea island cotton grows into a bush about five feet high, and on the Rewa the plants

are ready for picking when seven or eight months old; nine feet between the rows, and five from plant to plant, is considered the proper distance.

The mode of planting is somewhat peculiar. An intelligent native marks with a reed the planting spaces, and fastens strips of calico to the magi, on proper intervals, the ground being only disturbed at these spaces; to each line the requisite number of men and women are told off. A knife is the only agricultural implement a Fiji man uses, with which a lump of earth is displaced, the ground pulverised with the hand, and three seeds placed in a triangular form, and lightly covered with earth; in three days, under favourable circumstances, the plants are up. While the cotton is young, the weeds require to be carefully kept down; five weedings are usually required : so much for the *planting*.

Now as to the *profit* attending the crop: 300lbs. may be taken as an average produce per acre. The finest quality of sea island cotton in the London market is worth from 3*s*. to 4*s*. per pound. Should the cotton become stained, from exposure to wet, it is not worth half as much. 10 bales of cotton from the Island of Mango, containing some 350 lbs. per bale, were sold last year in the London market for 4*s*. 2*d*. per lb. yielding at least £62 10*s*. per acre. Allowing for stained and inferior qualities, £37 per acre is not too much to calculate on. One case has been mentioned to me, where a planter starting with a very small capital (some £500) received in two years £2400 in cash. The expenses incurred render a capital of £10 per acre requisite to start with. 30*s*. per acre is required for picking, 55*s*. for ginning, baling, and shipping; the expense attending the carriage from Sydney to London, and brokerage, is about 3*d*. per lb. This would amount to some £20, which would leave a profit of £17 10*s*. per acre on a produce of 300lbs. per acre, sold at 2*s*. 6*d*. per lb. This handsom ereturn is not, however, to be obtained without trouble and anxiety, chiefly arising from bargaining, contracting, axe-grinding, knife-sharpening, watching, disputing with and paying off the natives.

Domestic troubles too are to be met with in Fiji. Cooks and other household necessary evils can rarely be got to stay for more than one week, and the kitchens in Fiji are not the most agreeable places to do your own cooking in, chimneys not being deemed necessary for cooking purposes by Fijian architects. A house, such as it is, can be constructed 50 × 20, with a verandah round, for £7, roomy, cool, and clear, calculated to last three years; the walls constructed of posts, with the interstices filled in with reeds; roof thatched with flags, all tied together with vine or cocoa-nut sinnet; rafters bamboo, crossed over the ridge pole. Doors windows and flooring not included in the contract. The native carpenters are very handy in squaring or fitting wood, but are innocent of the use of nails or screws.

Proceeding up the Rewa, ranges of lofty hills are approached, the highest peak being about 4000 feet above the sea level. The mountain ranges in Fiji occupy the centre of the islands, with broad belts of level country intervening. The central hills are occupied by savage tribes

called Tevoro (Devils); there is very little sympathy between them and the more civilized inhabitants of the low lands. They regard as sacred their cannibal forks, which are handed down as heir-looms in the great families of the country. These forks are made of wood highly carved. On ordinary occasions the native Fiji uses his fingers when eating, at their cannibal feasts the forks are always used. On feast days they bronze their bodies with antimony, and present more the appearance of fine statues than men. The antimony is found in the hills; it was in these mountains the Reverend Mr. Baker was killed and eaten in 1867. The following year Cakobau endeavoured to punish the murderers, marching up the Rewa Valley with a force of 4000 men. Unfortunately a portion of his force went over to the enemy, which obliged Cakobau to retreat without obtaining any success.

In the mountains are scattered a few white settlers, with very promising cotton plantations, but their position is isolated and very dangerous. Returning down the Rewa, long rough sticks may be noticed standing in the river; these are Tabus; when hung with Kai shells they indicate the close season for Kai, and are as implicitly obeyed by the Fiji men as our game laws. Lofty palms and lovely fern trees abound on the banks of the river. Arriving at the Delta towns the pottery is noticeable as extremely good; the only tools employed in the manufacture are a piece of stick and a round stone. It is glazed with Kauri gum. This pottery is sent in large quantities to the hills, where it is exchanged for yams and taro.

On the coast and districts of the interior, where Christianity has been introduced, each town has a very well organized police, and a local Judge at its head in Cakobau's dominions. His brother Ratu Sa Vi Naca is the Chief Justice: he seems most anxious to do right, and minister justice fairly. There is often much difficulty in arranging disputes between the settlers and natives; and delays as harassing as sometimes occur in our own courts are not unfrequent, but cases brought before Ratu are settled in a very summary manner. In one instance the natives took possession of a planter's land, and commenced putting up buildings and planting bananas and taro; an attempt to stop them produced much ill-feeling; some persons advised the settler to bribe a local chief, a course which hitherto had been pursued. Instead of doing so, he brought the case before Sa Vinaca's court, who settled the matter very shortly; he told the Fiji men that they were to plant nothing without permission, and to bring tribute every season. Although such an angry feeling subsisted before judgment, they submitted to the law most implicitly, and regularly came for two years subsequently, and piled a quantity of their finest taros at his door. Few Fiji chiefs will move without being bribed; when sufficiently so they will carry out any request made by a settler, just or unjust.

Nothing is more remarkable in the history of Fiji, than the readiness with which the natives have adopted Christianity; probably in a vast majority of instances, their becoming Lotu, or Christians, is merely nominal, rather from the order of their chief than from conviction; still the

civilizing effect is most marked. When Cakobau conquered the Rewa Tribes, he forced them to Lotu, and the result has been most wonderful in altering their habits, and improving them in every respect. It is not too much to say that the utmost decency, order, and decorum prevail in their towns. I do not think that any case of cannibalism has been traced to a member of a tribe that had become Christian.

In conclusion, permit me to draw your attention to the very interesting specimens from Fiji on the table—the Orange Kowrie shell peculiar to Fiji; its value is about £25; you will perceive that it is pierced. When the King goes in procession, it is borne before him as a sceptre. The cotton is a sample of some grown by my friend Dr. Clarkson, which was sold in London recently. The cloth is manufactured from the bark of the Tappa tree.

XXII.—*Outline of a new Explanation of the Action of Sunlight on Iodide of Silver*. By Dr. J. Emerson Reynolds, Professor of Analytical Chemistry, and Keeper of the Minerals, Royal Dublin Society.

[Read June 3, 1872.]

White light is known to exert a very marked influence upon a very large number of chemical substances; but certain salts of silver are known to be specially subject to the action of the more refrangible rays of the spectrum. When light acts for a considerable time on iodide, bromide, or chloride of silver, evident *decomposition* occurs; but when the action is stopped before any sensible effect has been produced, the silver salt can be shown to have suffered profound change, in consequence of which its relations to chemical agents are almost wholly altered. All who have practised the beautiful and interesting art-science of photography well know that advantage is taken of this subtle action of light in the familiar operation of "taking a negative." A layer of iodide of silver (or of iodide, bromide, and nitrate of silver) is exposed for a short time in a camera to an image formed by a lens; the silver layer, on removal, is apparently in the same condition after as before exposure; but when an acidulated solution of ferrous sulphate is applied, the parts which have been exposed to the action of light become dark, while the other portions of the film are unaffected. The iron solution is then said to "develop" the "latent image."

Notwithstanding numerous and well-directed investigations, the nature of this "latent image" remains a mystery. Quite recently, however, some remarkable experiments upon the action of light on chlorine have been published by Dr. Budde, of Bonn, which appear to me to give a very distinct clue to the *modus operandi* of light, more particularly on the iodide of silver.

I propose now to lay before the Society, in the first instance, a brief

account of Dr. Budde's experiments, and his conclusions, and then to state the explanation of the nature and relations of the "latent image" on iodide of silver, which I have ventured to build upon the work of the German physicist.

It has been long well known that the blue and violet rays of solar light can determine the union of chlorine and hydrogen gases. The two bodies are freely miscible in the dark, without any chemical action taking place; but in diffused daylight the two gases slowly combine, and produce hydrochloric acid. If the mixture be exposed to direct sunlight, the same effect is obtained instantaneously, and a violent explosion is the consequence. The cause of this union, under these conditions, has not hitherto been traced out; but Dr. Budde has obtained the following remarkable evidence of the direct action of blue and violet light on pure chlorine gas:—

A quantity of chlorine gas was passed into a tube closed at one end, the gas being confined by a column of oil of vitriol saturated with chlorine, and the operation, of course, conducted as nearly as possible in the dark. A prismatic spectrum was formed in the usual way by means of a prism, and the several coloured rays, from red to ultra violet, allowed to fall in succession on the tube containing the chlorine, the latter being fixed in such a position that any alteration in volume which might take place during the experiment could be at once detected and estimated with the aid of an observing telescope, placed at a suitable distance. The red rays were allowed first to fall on the tube, but the effect produced was comparatively slight, as the maximum increase in the length of the gas column did not exceed the $\frac{1}{25}$th of an inch. The permanent expansion was greater in the more refrangible rays, until the maximum effect was obtained in the violet rays, the expansion being at least ten times greater than in the red rays, and this increase in volume was permanent. If the alteration of volume had been caused by heat, the expansion should be temporary, and, further, the effect ought to be much greater in the red than in the violet rays. It is evident that the observed expansion *might* have been due to the decomposition of the sulphuric acid by the chlorine; but this source of error seems to have been fairly eliminated by substituting for the sulphuric acid saturated with chlorine the tetrachloride of carbon. The same result was obtained with the latter as with the former liquid.

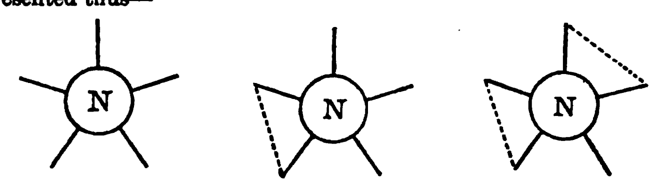
If the experiments are to be fully trusted, chlorine is proved to have its volume permanently increased by exposure to the violet rays.

Dr. Budde concludes, from the results of his experiments, that sunlight, or rather the violet rays, act by decomposing the molecules of the chlorine, setting free the component atoms of which the so-called "molecule" is supposed to be built up. The atoms must occupy a greater space when separate than when combined forming the molecule, and are also in a peculiarly favourable condition for entering into combination with those of a new body. The rapid combination of chlorine and hydrogen under the influence of sunlight is, therefore, no longer difficult of explanation.

If Dr. Budde's conclusion be accepted for chlorine, it clearly fol-

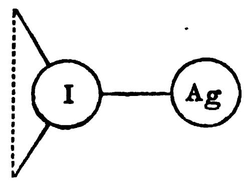
lows that all the cases known to photographers, in which light brings about chemical change, may be explained simply and naturally on the hypothesis of the partial or complete separation of the atoms of which the molecule of a given compound may be built up. We here seem to break new ground, and to get a clue to a sound theory of the latent image, which shall serve to explain the phenomena relied on by the supporters respectively of the present vibratory and chemical hypotheses. I would now venture to suggest an explanation of the action of light on iodide of silver which, *primâ facie*, seems to be complete.

It is well known that the atom of a chemical element is a sharply-defined relative quantity, but that the atoms of unlike matter often differ materially in the amount of chemical work they can perform ; thus an atom of sulphur can represent six atoms of hydrogen in combination; nitrogen five; carbon four; boron three; and oxygen two atoms of hydrogen; silver, on the contrary, only one. But this so-called "equivalence" of an element is not absolutely fixed, for, in some of its compounds nitrogen represents only three atoms of hydrogen—in ammonia, for instance—and in others, as in nitrous oxide, but one. This variation is now commonly accounted for by supposing that pairs of points of attraction on the atom of a polyequivalent element disappear by neutralising each other, and thus lie hidden in certain forms of combination. If we represent the atom of nitrogen by a circle, its pentequivalent, triequivalent, and monequivalent conditions may be represented thus—



In Nitric Acid. In Ammonia. In Nitrous Oxide.

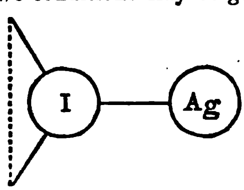
These points of attraction are now usually termed "bonds." Iodide of silver consists of one atom of silver and one of iodine. Now, the atom of silver is known to be equivalent to only one atom of hydrogen; but the study of organic and other iodine compounds teaches us that the atom of Iodine is equivalent to three of hydrogen, though in most compounds only appearing to be equivalent to one hydrogen atom. Representing graphically the atoms of silver and of iodine respectively by equal circles, and the equivalence of each atom by lines projecting from the circumference as usual now in graphic formulæ, we may represent ordinary iodide of silver in the following way :—



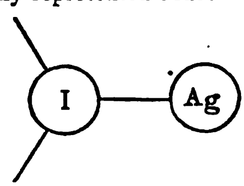
Here one of the three "bonds" or centres of attraction of iodine is united with the single bond of silver, the other two neutralising each other, as indicated by the dotted line, and so remaining latent. Up to this point I have advanced nothing new; but it is necessary to recognize these preliminary matters in accounting for the action of light on iodide of silver.

Common experience leads us to the conclusion that in many cases the action of light chiefly consists in the severance of the union of unlike bodies held in combination by comparatively feeble affinity; and the highly-interesting investigations of Dr. Budde would seem to go farther, and to prove that the same kind of action is inimical to the exercise of the still more feeble attractive force which tends to unite the atoms of like matter in molecules. We have only to extend the statement to the union of bonds in a single atom—as in the case of iodine—and we gain a perfectly intelligible conception of the nature of the influence exerted upon iodide of silver by light, and the cause of the well-known difference in chemical relations between the unexposed and exposed silver compound.

The two conditions may be graphically represented thus:—



Unexposed.



After exposure.

After, as before, exposure the compound is iodide of silver; but two of the three attractive powers of the iodine are now free from each other's control, and ready to enter into new combinations. It is evident that change may now take place in either of two directions. Firstly, the atom of iodide of silver may attract two additional atoms of silver or other analogous body to itself in so-called development; or, secondly, a complete separation of iodine from silver may arise, owing to the exercise of the superior power of the two free bonds of the former over the one attached to the silver atom. It appears by no means improbable that the first condition obtains in acid development with excess of silver, while in alkaline development the action is more likely to be chiefly of the second kind.

Up to the point at which it is necessary to assume that light is capable of severing the union between the latent "bonds" of iodine, the theory is in harmony with the current of thought in chemistry. But it is not yet generally admitted that a "bond" can remain free or unsatisfied. The existence of such apparently anomalous compounds as nitric oxide and certain of the chlorine oxides has, however, led some chemists to think that certain "atomicities" in a compound may remain free, and ready to enter into new combinations on a favourable oppor-

tunity presenting itself. The experiments of Dr. Budde on chlorine strongly support such a view; and, further, when we carefully consider the action of chlorine on olefiant gas, under the influence of sunlight, I see no difficulty in supposing light actually to have the power of severing the union between the latent "bonds" of an atom. I venture to think that this could take place even more easily in some cases than could the separation between the atoms of the molecule of a simple body, or—the much more difficult case—of the disunion of the unlike atoms of a compound such as iodide of silver. If, then, the last, and as must be admitted, the least likely case to occur is that which we can, in several compounds, actually observe, we are clearly warranted in assuming the much easier and, *à priori*, the more probable change to take place also.

Let us now apply the theory stated above to the explanation of some of the facts of development. I shall take at present only the case af acid development—with iron, for example—in the presence of excess of silver in the solution flooding the film. The acid present prevents the immediate deposition of metal; but still the exercise of even a very slight attractive power is capable of separating the silver from the liquid. The existence and exercise of the surplus chemical energy of the iodine atom of the exposed iodide of silver is amply sufficient to account for the attraction to the exposed iodide only of the metal silver, and this without assuming that the iodide of silver itself suffers any decomposition; in fact, the process appears to consist in the formation of a *sub-iodide* of silver by *addition* of silver to the exposed iodide, not by *abstraction* of iodine, as might be supposed. If such a definite compound be produced in the manner indicated, its formula most probably is

$$Ag_3 I,$$

for each of the three "bonds" of the iodine is now engaged with an atom of silver.

If the film be now fully washed after development, we have a layer of ordinary iodide of silver carrying an image formed of a sub-iodide of silver, the constituents of which are held together by comparatively feeble force; but it is by no means improbable that the determination of silver to the exposed iodide in the first instance, in order that the sub-iodide may be formed, facilitates the deposition at the same time and on the same part of the film of metallic silver in addition; so that we are not to look upon the image as consisting only of the sub-iodide, but as carrying some free silver also.

When the conditions of development are such as to admit of very rapid deposition of this so-called "supplementary" silver, we should expect the precipitation to be determined by that species of sympathy so often observed in chemical processes, acting even outside the sphere of attraction of the exposed iodide of silver, and thus give rise to the well-known phenomena of solarization and of fog. Assuming the image to be free from these defects, however, its subsequent intensification re-

sults from the well-known attraction of silver for silver on the point of deposition from solution.

Fixation by hyposulphite of sodium, or similar agent, in my view of the matter, consists in the decomposition of the above-mentioned sub-iodide of silver, ordinary iodide of silver dissolving, and the excess of silver remaining, and forming the image in its final condition.

Such is the view which I venture to take of the action of light on iodide of silver, so far as the production of the "latent image" is concerned. The most reliable experiments have proved perfectly pure iodide of silver to be sensitive to light; it is, therefore, unnecessary for me to extend this paper beyond reasonable limits by discussing the details of photographic processes, in which iodide of silver plays the chief part; but I should add that, so far as I am aware, there are no facts which the theory just proposed is not capable of simply explaining. Further, when the apparently-conflicting statements of the physical and chemical schools of thinkers on this subject are reconciled on the physico-chemical theory which I have advanced, we may fairly regard the latter as a safe aid to investigation. I have only to add that the above sketch of a new theory of the "latent image" is to a large extent derived from several detailed articles which I published in the last volume of the "British Journal of Photography."

XXIII.—*On a New Angle-Measurer and Protractor, for facilitating the Processes of Field Sketching and Surveying.* By Major W. H. Collins, Major R. E., F. R. A. S.

[Read June 3, 1872.]

The figure represents an instrument which I am desirous of submitting to the notice of the members of the Royal Dublin Society. This instrument has been designed by me to facilitate the operation of field sketching and military reconnoissance.

Land surveys of large extent are based upon *angular* measurement; a short distance only is measured, and the longer distances are inferred by calculation. In surveys of small extent, all measurement is linear, and the areas enclosed by any assigned figure, bounded by straight lines, can be easily estimated, but such procedure ceases to be possible where the boundary lines are long, or the tract to be covered by the survey is large. With surveys pretending to much accuracy, the angular measurement must be made the basis of trigonometrical calculation, the calculated distances containing the error of the original line in an increased proportion.

When it is unnecessary to obtain great accuracy, the angles ascertained may be plotted upon paper, and the loci of points determined, the intersections of such loci defining the position of remote points.

This latter procedure is that of necessity adopted in millitary re-

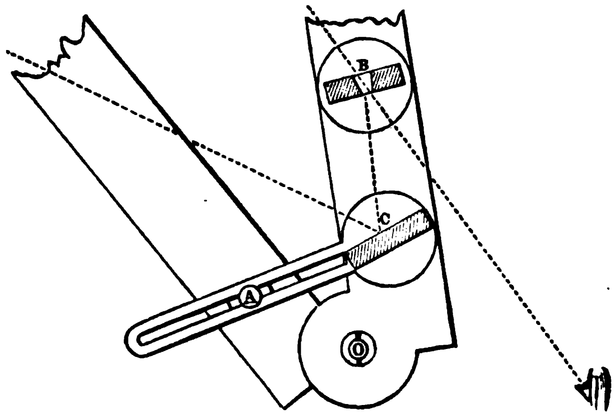
connoissances, and other cases, where the work must be rapidly executed, and extreme accuracy is not necessary. The instruments usually made use of are the pocket sextant, and the prismatic compass. The first is accurate, though inconvenient, and the latter convenient, though inaccurate. The instrument proposed by me as a substitute for both sextant and compass is a reflecting instrument, so contrived as to *exhibit* the angle subtended at the eye by two objects.

Reflecting angle-measuring instruments are based upon the fact that the angle through which a mirror is turned is a measure of the angle through which a ray of light reflected by it is displaced—the former being half the latter. In the sextant, an index arm is attached to the reflector, and made to traverse a graduated arc. This arc is divided, so as to contain twice the number of degrees that it really holds, and, consequently, any angle read off represents twice the angle through which the mirror has been turned, or the angle between the two positions of the reflected ray. The graduations of the arc are necessarily crowded together, each 30′ representing 1°, 1° representing 2°, &c. The difficulty of reading the angle is increased, while the accuracy of the reading is diminished. In field sketching, such as that referred to above, where angles are plotted upon paper, and are not used as the basis of calculation, the value of the angles in degrees and minutes is not required, inasmuch as no use would be made of such values beyond the arriving at the position of a line on the paper. The reading of the angle by a microscope and vernier becomes an inconvenient step, and one gladly to be dispensed with if possible. The protractor, also, with which the angle would be plotted does not read within 30′, while the vernier reads to a second.

Under these circumstances, it appeared desirable to produce an instrument which would exhibit in itself the angle subtended at the eye by two points, and allow it to be plotted at once, and thus remove the necessity for intermediate operations. Such an instrument is that represented by the figure. It becomes necessary to contrive two angular motions depending upon each other; one half the other. If a reflector moved with the first, the second would represent the movement of the reflected ray. Cog-wheels were the first expedient that suggested itself to procure such a motion, but these were abandoned for what appeared more desirable, viz., the geometrical necessity of some figure. That of which I have availed myself is this—that the base of an isosceles triangle moves with half the angular motion of one of its sides, the other remaining fixed, and the angle of the vortex being supposed to expand. After much adaptation and alteration, the instrument took the form shown in the figure. The centre of the sector is made the centre of the isoceles triangle, at the extremity of one leg of which is the centre of the index mirror, at the extremity of the other the centre of the moveable spud A, which slides between two guides upon the base.

The operation of the instrument is obvious on looking at the figure. When the legs are closed the two mirrors are parallel, and the object

seen *direct* over the smaller mirror is seen also reflected in it. On



Points A and C equidistant from O the centre of pivot, the mirror B is parallel with C when the instrument is closed.

opening the instrument, other objects are seen reflected in the small mirror, and the angle exhibited by the legs is that subtended at the centre of the moveable mirror by the two objects, seen one direct, and the other by reflection immediately below. The pivot is pierced with a small hole, to allow the paper to be seen through, and to allow a pencil-mark to be made. The right-hand object is looked at, and reflected image of the left-hand object made to appear below it in the small glass.

This instrument has been tested both with a theodolite and quadrant, and the angles in each case plotted upon paper; the results were identical.

XXIV.—*Notes on the Hæmatites of Counties of Cavan and Longford.* By Professor Edward Hull, M. A., F. R. S., &c., Director of the Geological Survey of Ireland.

[Read June 3, 1872.]

The recent extraordinary rise in the price of iron, and the great demand for hæmatite ores, suited for the manufacture of Bessemer steel, has drawn attention to localities where such ores exist, but which have hitherto been neglected.

The Lower Silurian rocks of Longford and Cavan were known, for some time past, to have possessed such ores; but, until railways, communicating with shipping ports, were constructed, there was little prospect of these ores being turned to profitable account. This obstacle has

now been overcome, and the hæmatite ores are now sent by the Midland and North-Western lines, to be shipped at Dublin and Dundalk to the iron-furnaces of the North of England and Wales.

These ores are known to exist in at least four localities, three of which lie in the district between Granard and Carrick-on-Shannon, and another in the district between Cavan and Ballybay.

South of Arvagh, on the western banks of Lough Gowna, the ore is being worked, and is brought, partly by boats, and then by a branch line of railway, into connexion with the Cavan Junction and Midland Great Western Railway. This ore, and that of the localities in this district, will shortly be described in detail in one of the Explanatory Memoirs of the Geological Survey, now being prepared for publication. I shall not, therefore, further allude to it here, except to state that these ores are everywhere similar in character, being siliceous brown hæmatites, varying in quality according to the proportion of silica, and thus passing into jaspery iron-ore. They also follow, with more or less regularity, the stratification of the rocks in the neighbourhood.

I shall now pass on to give some account of the iron-ore at Red Hills, near Belturbet, which I have recently visited, and which lies in a district not yet examined by the officers of the Geological Survey.

The ore here has been traced at intervals in a S. W. and N. E. direction, for a distance of about six miles, following the strike of the Silurian rocks, from Ballyhaise through Red Hills to the grounds of Scott's House, the residence of Mr. Madden. Whether it is perfectly continuous throughout this distance is uncertain, as the strata are frequently concealed by boulder clay; but in any case the quantity of ore must be very large; and if we suppose, as we have every right to do, that the ore follows the stratification of the rock inwards, below the surface, the quantity must be absolutely incalculable.

At Red Hills, the property of the Rev. E. B. Whyte-Venables, the ore is now being vigorously worked by an English company, and is carted from the mine or quarry to a landing-stage on the Cavan and Clones railway, from whence it is carried to Dundalk, and shipped to Cumberland, Lancashire, and North Wales. The works were commenced only this year, and already upwards of 5000 tons have been shipped off.

The hill on which the principal excavations are now in progress shows the following approximate section of the strata :—

1. *At the top.*—Siliceous hæmatite, sometimes passing into red and green jasper (only locally workable). . . . 2. *Best ore.*—Dark fissile brown hæmatite, about 12 feet in thickness. . . . . 3. *Inferior quality.*—Siliceous brown hæmatite, irregularly accumulated, passing into jaspery rock.	About 50 feet in thickness.
4. Reddish shales, of considerable thickness, sunk through in a pit for 30 feet. .	65 feet.

In appearance, the ore, when opened out, seems almost devoid of definite arrangement, or structure; and it is only when it is in contact with beds of shale or grit that it can be observed to coincide approximately with the bedding of the rock. It, therefore, does not occur as a lode or vein, traversing the strata in a highly inclined position, but rather in the form of lenticular beds, of extreme irregularity. The ore itself is split up by innumerable planes of jointage or false-cleavage, traversing the mass in various directions.

An analysis of the Red Hills ore, by Mr. John Cameron, F. C. S., of Askam-in-Furness, for the Red Hills Mining Company, shows that the ore is well suited for the manufacture of Bessemer steel, phosphorus and sulphur being entirely absent. The analysis was kindly presented to me by Mr. Whyte Venables.

Analysis of Red Hills Iron-ore.

Peroxide of iron,	57.57
,, manganese,	traces.
Protoxide,	6.20
Alumina,	8.93
Carbonate of lime,	0.50
Silica,	22.80
Water of Combination,	3.00
Soluble matter,	1.00
	100.00

Amount of metallic iron, 40.30 per cent.

XXV.—*Return of Donations to the Royal Dublin Society.*

THE LIBRARY.

THE AUTHOR.

Alanus (Henr.) Observationes in *Aemilii Probi* de Excellentibus Ducis . . . Librum. Addita sunt pauca in *Cornelii Repotis* vitam Attici. 12mo. *Dublinii:* . . . 1872

THE PUBLISHER.

Anderson (Benjamin), Narrative of a Journey to Musardu, the Capital of the Western Mandingoes. 8vo. *New York:* 1870.

Anderson's Journey to Musada, Appendix to. . . . Facsimile of a Letter. . . . written by a young Mandigo . . . in Arabic, in 1868 . . . with a Translation by the Rev. Edward W. *Blyden*, Professor in Liberia College 8vo. *New York:* 1870.

THE PUBLISHER.

Annuaire Litteraire; Catalogue des principaux Ouvrages publiés en France en 1870–1871. 8vo. *Paris: Londres:* 1872

Messrs. H. Sotheran & Co., 136 Strand, London, W. C.

Annual of the Royal School of Naval Architecture and Marine Engineering.
[No. 1] 8vo. *London:* 1871
[No. 2] ,, *London*, 1872

ΕΘΝΙΚΗ ΒΙΒΛΙΟΘΗΚΗ ΤΗΣ ΕΛΛΑΔΟΣ, through the Foreign Office, London.

ΑΠΟΛΟΓΙΣΜΟΣ *των άχρι τουδε γένομενων Δαπάνων της οίκοδόμης τον* ΕΘΝΙΚΟΥ ΑΡΧΑΙΟΛΟΓΙΚΟΥ ΜΟΥΣΕΙΟΥ.
Folio. *εν 'Αθήναις:* 1871

Wm. H. Archer, Registrar General, Victoria.

Archer (William Henry, Registrar General of Victoria), Victoria.—Abstracts of Specifications of Patents applied for from 1854 to 1866. Metals.—Part I., . . . 4to. *Melbourne:* 1872

The Author.

Armagh (Marcus Gervais, Archbishop of, and Bishop of Clogher), A Charge addressed to the Clergy of the Dioceses of Armagh and Clogher, at the Annual Visitation, 1864.
8vo. *Dublin*, 1865

The Author.

Blacker (The Rev. Beaver H., M. A., . . . Rural Dean), Brief Sketches of the Parishes of Booterstown and Donnybrook, in the County of Dublin, with Notes and Annals. Third Part.
8vo. *Dublin:* 1872

La Société Royal des Sciences à Upsal.

Bulletin Météorologique Mensuel de l'Observatiore de l'Université d'*Upsal*. Rédigé par Dr. R. *Rubenson*.
Vol. I. Année, 1869. *Upsal*, 1871
Vol. II. ,, 1870. ,, 1870
Vol. III. ,, 1871. ,, 1871

The Author.

Carroll (Rev. W. G.). The Right Hon. Chichester Fortescue, Lord Hartington, Government Informers, Irish Education, and Home Rule . . . A Speech at . . . Dundalk . . . on Jan. 4, 1872. 8vo. *Dublin:* 1872

Lord Talbot de Malahide.

Cobbett (William), *Porcupine's Works;* . . . a faithful Picture of the United States of America; . . . from . . . 1783 to . . . 1801. In Twelve Volumes. 8vo. *London:* 1801

The Royal Society, London.

Correspondence concerning the Great Melbourne Telescope. In Three Parts: 1852–1870. *Printed, for private circulation only, by order of the Council of the Royal Society.* 8vo. *London:* 1871

The Editor.

Dallan Forgaill: The Amra *Choluim Chilli of:* . . . printed . . . from the Original Irish in Lebor na huidre, a MS. in the . . . Royal Irish Academy; with a . . . Translation and Notes . . . Edited by J. O'Beirne *Crowe*, A. B.; . . . Examiner in Celtic for the Queen's University in Ireland. 8vo. *Dublin:* 1871

HENRY HILLSWORTH, CLERK, 102 CORK STREET.

Evans (John, LL. D. . .) A Sketch of the Denominations of the Christian World; . . . of Atheism, Deism, Theophilanthrophism, Mahometanism, Judaism . . . the Shakers, Jerkers, Barkers . . . in America . . . Fourteenth edition. 12mo. *London:* 1821

THE SCIENCE AND ART DEPARTMENT, SOUTH KENSINGTON, LONDON, W.

Exposition Universelle de Paris en 1867.
Tomes I, II, III, Documents et Rapports. *Bruxelles*, 1868
Tome IV, Jury Belge. 8vo. *Bruxelles*, 1870

THE AUTHOR.

Fitzgibbon (Gerald, Esq., Master in Chancery, . . .) Roman Catholic Priests and National Schools. Second Edition, with an Appendix. 8vo. *Dublin:* 1872

THE AUTHOR.

Grattan (Richard, M. D., . . .) Suggestions for the Repeal of the Act of Union . . . between Great Britain and Ireland. 8vo. *Dublin:* 1871

THE AUTHOR.

Grimshaw (Thomas W., M. D., Dublin), Remarks on the Prevalence and Distribution of Fever in Dublin . . . 8vo. *Dublin:* 1872

THE AUTHOR.

Hickson (Robert Conway, J. P.) "Let well alone." The Vaccination Question, and the Compulsory Law. Also, a Letter on the Cattle Plague. 8vo. *Tralee:* 1866

THE AUTHOR.

Hunt (James, Ph. D., F. S. A., F. R. S. L., . . . President,), Collection of Addresses [*separately printed and paged*] on Anthropology, delivered before the Anthropological Society of London. 8vo. *London:* 1863, 1864, 1865, 1866, 1867

ΕΘΝΙΚΗ ΒΙΒΛΙΟΘΗΚΗ ΤΗΣ ΕΛΛΑΔΟΣ, THROUGH THE FOREIGN OFFICE, LONDON.

ΚΑΣΤΟΡΧΗ (*Ευθυμιου*) *Περι της αρχηθεν κοινωνιας των* Ελληνων *προς τους* Ιταλους *και* Ρωμαιους. . . . 8vo. *'Αθηνησι*: 1872

ΚΑΤΑΛΟΓΌΣ *τῶν 'Αρχαίων Νομισμάτων Χωρων, Ἔθνων, Πόλεων καὶ Βασιλεων του 'Αθήνησιν 'Εθνικοῦ Νομισμάτικοῦ Μουσείου, κατατεταγμενων και περιγεγραμμενων υπο Αχιλλεως* ΠΟΣΤΟΛΑΚΑ . . . *Τόμος* Α.' 4to. *'Αθήνησιν, ͵αωόβ'.*

ΚΡΙΣΙΣ *του* ΒΟΥΤΣΙΝΑΙΟΥ ΠΟΙΗΤΙΚΟΥ ΑΓΩΝΟΣ *εν* Ετει ΑΩΟ' . . .
Υπο του εισηγητου Θεοδωρου Γ. ΟΡΦΑΝΙΔΟΥ. . . . 8vo. *εν Αθηναις*: 1870

ΚΡΙΣΙΣ *του* ΒΟΥΤΣΙΝΑΙΟΥ ΠΟΙΗΤΙΚΟΥ ΑΓΩΝΟΣ *του* Ετους 1871. . . .
Υπο του εισηγητου Γεωργιου ΜΙΣΤΡΙΩΤΟΥ. 8vo. *Αθηνησι*: 1871

ΕΘΝΙΚΗ ΒΙΒΛΙΟΘΗΚΗ ΤΗΣ ΕΛΛΑΔΟΣ, THROUGH THE FOREIGN OFFICE, LONDON.

ΛΟΓΟΣ . . . *εκφωνηθεις εν τῳ ἱερῳ της Μητροπολεως Ναῳ: υπο Νικηφορου* ΚΑΛΟΓΕΡΑ, *ἀρχιμανδρίτου . . . τῃ* 30 *Ιανουαριου* 1872. . . . 8vo. *Ἀθηνησιν*: 1872

ΛΟΓΟΣ *εκφωνηθεις τῃ κη' Νοεμβριου* 1871 . . . *υπο του ηρωην πρυτανεως Κωνσταντινου* ΒΟΥΣΑΚΗ . . . *παραδιδοντος την πρυτανειαν τῳ διαδοχῳ Ευθυμιῳ* ΚΑΣΤΟΡΧΗι . . . 8vo. *εν Αθηναις*: 1872

THE PUBLISHER.

M'Cutchan (George, A. B.) The Irish Church and the Irish Nation: a Sermon preached on the First day of January, 1871, in . . . Kenmare. 8vo. *Dublin*: 1871

THE AUTHOR.

Mapother (E. D., M. D. . . .) Lisdoonvarna Spas and Sea-side Places of Clare. Second Edition. 8vo. *Dublin*: 1872.

Mapother (E. D., M. D. . . .) The treatment of Chronic Skin Diseases: . . . with an Appendix on Lisdoonvarna Spas. 16mo. *London*: 1872

THE AUTHOR.

Morgan (John, A. M., M. D., Univ. of Dublin; . . . Practical Lessons in the Nature and Treatment of . . . the Contagious Diseases; . . . 8vo. *London*: 1872

THE AUTHOR.

Morgan (John, M. D., F. R. C. S., . . .) Remarks on the recent Report of the Royal Commission on the Contagious Diseases Act . . . 8vo. *London*: 1872

MESSRS. CASSELL, PETTER, AND GALPIN, LA BELLE SAUVAGE YARD, LUDGATE HILL, LONDON.

Morton (John C., . . .), 1872. Morton's Almanack for Farmers and Landowners. 4to. *London and New York*: *s. a.* [1872.]

DR. P. A. BERGSMA, BY ORDERS OF THE GOVERNMENT OF NETHERLANDS INDIA.

Observations made at the . . . Observatory at Batavia . . . Vol. I. Meteorological Observations from January 1st, 1866, to December 31st, 1868, and Magnetical Observations from July 1st, 1867, to June 30th, 1870, made under the direction of Dr. P. A. *Bergsma*. Folio. *Batavia*: 1871

COLONEL W. R. HALIDAY, COMMANDANT AND INSPECTOR GENERAL, HYTHE.

ΠΙΝΔΑΡΟΥ ΟΛΥΜΠΙΑ. Ex editione Oxoniensi . . . *Glasguae*: 1754

THE LITERARY AND PHILOSOPHICAL SOCIETY OF LIVERPOOL.

Proceedings of the Literary and Philosophical Society of Liverpool, during the Sixtieth Session, 1870–71. No. xxv. 8vo. *London*: 1871

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

Proceedings of the Academy of Natural Sciences of Philadelphia.

New Series.	Part I.	8vo.	*Philadelphia*:	1871
	,, II.	,,	,, ,,	,,
	,, III.	,,	,, ,,	1872

THE ZOOLOGICAL SOCIETY OF LONDON.

Proceedings of the Scientific Meetings of the Zoological Society of London for the year 1871.

Part I. March—June.

Part II. November—December.

for the year 1872.

Part I. January—March.

8vo. *London: s. a.*

THE REGISTRAR GENERAL, QUEENSLAND.

. . . *Queensland.* Census of 1871, taken on the 1st day of September, being the Fourth taken in the Colony . . . Folio. *Brisbane* [1872.]

THE MUSEUM OF COMPARATIVE ZOOLOGY AT HARVARD COLLEGE, CAMBRIDGE, MASSACHUSETTS.

Report (Annual), of the . . . Museum of Comparative Zoölogy, at Harvard College, in Cambridge: . . . for 1871. 8vo. *Boston:* 1872

THE ROYAL OBSERVATORY, CAPE OF GOOD HOPE.

Results of Astronomical Observations made at the Royal Observatory, Cape of Good Hope, in the year 1856, under the Superintendence of Sir Thomas *Maclear*, Kt., F. R. S., F. R. A. S., . . . and . . . *Edward James Stone*, M. A., F. R. S., F. R. A. S., . . . 8vo. *Cape Town:* 1871

THE AUTHOR.

Reynolds (J. Emerson, M. R. C. P., Edin., Keeper of the Mineral Department, and Analyst to the Royal Dublin Society), Mineralogical Tables, arranged . . . to facilitate the Examination of the Mineral Collection of the *Royal Dublin Society* . . . 8vo. *Dublin:* 1871

HER MAJESTY'S SECRETARY OF STATE FOR INDIA IN COUNCIL.

Rig-Veda-Sanhita, the Sacred Hymns of the Brahmans, . . . with the Commentary of *Sayanacharya.* Edited by F. Max *Müller*, M. A., . . . Volume V. 4to. *London:* 1872

THE COUNCIL OF THE ROYAL INSTITUTE OF THE ARCHITECTS OF IRELAND.

Royal Institute of the Architects of Ireland—Sessional Papers 1863–4 to 1869–70. 4to. *Dublin, s. a.*

THE EDITOR.

Saint Thomas's Hospital Reports. New Series.

Edited by Dr. *Bristowe*, Dr. *Stone*, and Mr. *Croft.* Vol. II. 8vo. *London:* 1871

THE EDITOR, F. BUCHANAN WHITE, M. D.

Scottish Naturalist (The), January, 1872. No. V.—Vol. I. 8vo. *Perth:* . . . [1872.]

THE REGISTRAR GENERAL, SOUTH AUSTRALIA, ADELAIDE.

South Australia. Blue Book for 1870 . . . Folio. *Adelaide:* 1871

South Australia.—Agricultural and Live Stock Statistics for the year ending March 31st, 1872; with Prefatory Report . . . Folio. *Adelaide:* 1872

THE REGISTRAR-GENERAL, SOUTH AUSTRALIA, ADELAIDE.
Statistical Register of South Australia for 1870 . . . Folio. *Adelaide:* 1871

JOHN B. BENNETT, REGISTRAR GENERAL, NEW ZEALAND.
Statistics of New Zealand for 1870. Compiled from Official Records . . . Folio. *Wellington:* 1872

DE PART DE LA SOCIÉTÉ DE PHYSIQUE ET D'HISTOIRE NATURELLE DE GENEVE.
Transactions. Memoires de la Société de Physique et d'Histoire Naturelle de Genéve. Tome xxi. Premiére Partie. 4to. *Genève:* 1871

THE NEW ZEALAND INSTITUTE.
Transactions and Proceedings of the New Zealand Institute, 1871. Vol. IV. Edited and Published . . . by James *Hector*, M. D., F. R. S. Issued May, 1872. 8vo. *Wellington: s. a.*

THE PATHOLOGICAL SOCIETY OF LONDON.
Transactions of the Pathological Society of London. Volume Twenty-second . . . Session 1870–71. 8vo. *London:* 1871

HOMMAGE DE LA SOCIÉTÉ ROYAL DER SCIENCES Á UPSAL.
Transactions. Nova acta Regiae Societatis Scientiarum Upsaliensis. Seriei Tertiae. Vol. vii. Fasciculus Prior, Upsaliae, 1869
,, ,, ,, ,, ,, Posterior. ,, 1870
,, ,, Vol. viii. Fasciculus Prior. ,, 1871

THE AUTHOR.
Travers (Robert, A. M., M. B., . . ., College Professor of Medical Jurisprudence in the School of Physic, University of Dublin; . . .) Essay on Personal Identity, and its Proof from Physical Signs. 8vo. *Dublin:* 1872

JOHN H. W. COSBY, ESQ., 41 PEMBROKE-ROAD.
Walsh (W. Pakenham, A. M., Chaplain of Sandford, Dublin.) The Moabite Stone. The Substance of two Lectures. 8vo. *Dublin:* 1872

MRS. HUTTON, FITZWILLIAM-PLACE.
Works of the English Poets, from *Chaucer* to *Cowper:* including the Series edited, with Prefaces, Biographical and Critical, by Dr. Samuel *Johnson:* . . . . the additional Lives by Alexander *Chalmers,* F. S. A. In Twenty-one Volumes. 8vo. *London:* 1810

THE ZOOLOGICAL SOCIETY OF LONDON.
Zoological Society of London. Revised List of the Vertebrated Animals now or lately living in the Gardens of, 1872. 8vo. *London: s. a.*

(Signed) EDW. RICHARDS PUREFOY COLLES,
September 30*th*, 1872. *Librarian.*

BOTANIC GARDEN.

Miss Hamilton, *Greytown, Central America* :—2 parcels of Seeds.

Dr. Jameson, *Superintendent Botanic Garden, Saharumpore, E. Indies* :—Large collection of Seeds of Indian Conifers.

Mrs. Haughton, *Moorfield, Roebuck, Dundrum* :—Parcel of Indian Seeds.

His Excellency T. F. Callaghan, *Government House, Gambia, West Africa* :—Boxful of Bulbous Roots from West Africa (*good*).

Indian Museum, *Calcutta* (no return of donor):—Parcel of Seeds of Palms.

Dr. Hooker, *Kew* :—Parcel of Bulbs of rare Narcissus.

Indian Museum, Calcutta:—Parcel of Seeds of Cedrus deodara.

Edward Wilson, Esq., 21, *Russell Place, Dublin* :—1 Kaffir Necklace, and 2 Kaffir Rugs, for Botanical Museum.

Miss Birch, 7, *Tivoli Terrace, Kingstown* :—1 Parcel of Seeds.

Baron von Mueller, *Director Botanic Garden, Melbourne* :—36 papers rare Seeds.

D. J. Schomburgk, Esq., *Director, Botanic Garden, Adelaide, Queensland, Australia* :—95 papers of rare Seeds.

Herr Wendland, *Director, Botanic Garden, Herrenhausen, Hanover* :—27 different kinds of Palms, Cycads, &c. (valuable).

Dr. Jameson, *Superintendent, Botanical Garden, Saharumpore* :—2 large parcels of Seeds of rare plants.

Hean Watts, Esq., *Commissioner of Agriculture, Washington, U. S.* :—2 parcels of Seeds.

Dr. Hooker, *Royal Gardens, Kew* :—22 species of rare and valuable Plants.

Herr Meyer, *Inspector, Botanical Garden, Carlsruhe, Grand Duchy of Baden* :—17 species of rare Plants.

Herr Max Leichtlin, *Carlsruhe, Duchy of Baden* :—Some Bulbs of several newly introduced Liliums.

Herr Ortgies, *Inspector, Botanical Garden, Zurich, Switzerland* :—60 kinds of rare tender and hardy Plants.

J. E. Vernon, Esq., D. L., *Mount Merrion, Stillorgan* :—Large parcel of the newer Pelargoniums and other bedding-out Plants.

William Wilson Saunders, Esq., *Hillfield, Reigate, Surrey* :—A selection of Agavas, rare Bulbs, and Orchids (valuable).

J. Taherne Moggridge, Esq., *Mentone, Alpes Maritimes, France* :—2 parcels of rare kinds of Seeds.

Captain Hamilton, 107th Regt. *Dum-Dum, Calcutta* :—7 large parcels of Seeds, through M. Mills, Esq., 12, *Upper Temple-street.*

Herr Max Leichtlin, *Carlsruhe, Duchy of Baden* ;—Parcel of hardy Plants.

Royal Gardens, Kew :—160 packages of Seeds.

Dr. Martens, *Botanic Garden, Montpellier, France*:—50 packages Seeds.

John Tyreman, Esq., *Penlee House, Tryony, Cornwall*:—12 packages of Seeds.

Royal Horicultural Society's Gardens, London, through Professor Dwyer:—50 packages of Seeds.

Dr. Reichenbach, *Botanic Garden, Hamburgh*:—89 packages of Seeds.

M. Decaisne, *Department Museum, D'Histoire Naturelles a Paris*:—111 packages of Seeds.

Signor Todaro, *Botanic Garden, Palermo*:—204 packages of Seeds.

Dr. Caspray, *Botanic Garden, Konigsberg*:—75 packages of Seeds.

Baron von Mueller, *Botanic Garden, Melbourne, Australia*:—5 packages Seeds.

Dowager Lady Ormonde, *Kilkenny*:—Curious Excrescence which grows on trees in Mexico.

Lord W. Butler, *Kilkenny*:—Fruit of Wooden Pear, Xylomelum Pyriforme, from Australia.

G. J. Robertson, Esq., *Kilkenny*:—Whip, made from bark of Lagetta lintearia, from Fiji Islands. Piece of Cloth made from same plant, along with several other articles for Botanical Museum.

N. King, Esq., *Rathfeston House, Geashill*:—3 papers of Australian Seeds.

Dr. Paterson, *Bridge of Allan*:—2 Germinating Cocoa Nuts.

Mr. George Brett, *Belfast Foundry*:—Seeds from California.

J. D. Hooker, M.D., C. B., &c., *Kew*:—Plant of Victoria Regina.

Miss Bunbury, *Picton, Western Australia*:—7 papers of Seeds.

The Rev. T. Doran Falkiner, *Carrigans, Londonderry*:—13 papers of Seeds from Madras.

Miss Hamilton, 5, *Victoria Terrace, Clontarf*:—Boxful of Plants and Seeds; also several articles for the Botanical Museum.

Dr. Jameson, *Superintendent &c., of Botanic Garden, Saharumpore, N. W. Provinces of India*:—Large parcel of Seeds of Pinus longifolia.

Charles Moore, Esq., F. L. S., *Director, Botanic Garden, Sydney, New South Wales*:—70 papers of Seeds, collected in interior of New South Wales.

David Moore, *Director*.

28*th June*, 1872.

NATURAL HISTORY MUSEUM.

G. L. W. Adair, R. N., through John Adair, Esq., 13 *Merrion-square*:—Three carved figures from New Zealand; a piece of Native Cloth from Ovalau, one of the Fiji Islands; Two Bracelets made of Cocoa-nut, from the New Hebrides; Two Necklaces and a Comb from Maræ Islands, New Caledonia.

R. P. WILLIAMS, Esq., *Dame-street*:—A specimen of the Sandwich Island Goose, which had died in his Aviary.

DR. BATTERSBY, *Glendalough, Lough Carra, Kerry*:—A number of Pliocene Fossil Shells from Cannes.

ROBERT TAYLOR, Esq., *Corballis, Drogheda*:—A White Peacock.

J. B. BRAY, Esq., 15, *D'Olier-street*:—A Kasso, or African Banjo, from Senegambia.

A. P. ALLEN, Esq., 1, *Lower Sherrard-street, Dublin*:—Two pieces of Matting from Madagascar.

MISS BOOKEY, 7, *Haddington-terrace, Kingstown*:—Six Birds-skins from India and Australia.

W. M. BARRINGTON, Esq., 58, *Fitzwilliam-square, Dublin*:—A specimen of Müller's Top-knot (*Rhombus Punctatus*) taken at Kingstown.

JOHN T. CAMPION, Esq., per J. G. ROBERTSON, Esq., *Kilkenny*:—A dress of a North American Indian.

J. G. ROBERTSON, Esq., *Prior's Orchard, Kilkenny*:—Skull of a Porpoise, and Jaws of a Shark, &c.

CAPTAIN NEEDHAM, *Cahersiveen, Co. Kerry*:—A South-American Lasso.

MASTER GERALD ADAIR, 13, *Merrion-square*:—A Necklace from the Fiji Islands.

DR. THOMAS D'ARCY BROMLOW, R. N., *H. M. S. Favorite*, 2, *Queen's Ferry, Edinburgh*:—Skull of a Turtle (*Chelonia Midas*) from Ascension.

DR. W. R. M'NAB, *Royal College of Science, Stephen's-green*:—Some specimens of rare British Coleoptera.

DR. FOOT, 21, *Lower Pembroke-street*:—Specimens of 30 species of Irish Hymenoptera and Diptera.

CAPTAIN H. KELSALL, 16TH REGT., 4, *St. James-terrace, Clonskea*:—130 specimens of Lepidoptera from Trinidad; A Skin of *Nettapus albipennis* from Australia, and a Skin of *Todus viridis* from Jamaica.

J. O'NEILL, Esq., M. L. C., *Auckland, New Zealand*:—A Centipede from Honoloolo, Sandwich Islands.

MRS. MINCHIN:—A Black-backed Gull and a Stilt from New Zealand.

JAMES ROYSTON, Esq., *King-street, Athlone*:—Two eggs of the Red-breasted Merganser, an egg of the Little Grebe, taken on Lough Rea, and a Skin of the Great Northern Diver.

R. P. WILLIAMS, Esq., 38, *Dame-street*:—A Gosling of the Ashy-headed Goose (*Chloëphaga poliocephala*) hatched at Clontarf.

A. P. ALLEN, Esq., 9, *Lower Sherrard-street*:—A piece of Native Matting made of bark, from the Marquesas Islands.

HENRY WOODWARD, Esq., *British Museum*:—A cast of *Astropecten Cottswoldiæ*.

J. G. ROBERTSON, Esq., *Prior's Orchard, Kilkenny*:—Fifty Birds' Skins from various localities.

WILLIAM TALBOT, Esq., *Tarbert, Kerry*:—Some native Lepidoptera, collected near Tarbert.

R. D. Hime, Esq., B. C. S., 44, *Raglan-road*:—Twenty-nine Birds' Skins from India.

Robert Warren, Esq., jun., *Moyview, Ballina*:—Five specimens of the Redshank (*Totanus calidris.*)

Sir Francis Brady, Bart., 6, *Pembroke-street, Upper*:—A Neptune's Cup (*Raphophora patera.*)

Mrs. Thomas S. Wright, 78, *Lower Mount-street*:—Three dresses, made from the bark of a tree, worn by the natives of the Fiji Islands.

Maurice Fitzgerald, Esq., *The Palace, Killaloe*:—Specimens of Boracite Borochloride of Magnesium from Lüneberg, Hanover.

Dr. Templeton, *Royal Military School, Phœnix Park*:—A few Reptiles and Fish from Ceylon and India.

Joshua K. Millner, Esq., *Blackrock*:—A short-eared Owl (*Otus brachyotus.*)

Miss C. H. Stephens, 4, *Blackhall-place*:—A Cuttle-fish.

Robert H. Scott, F. R. S., *Meteorological Office*, 116, *Victoria-street, London, S. W.*:—A specimen of Meteoric Iron, from the large block weighing 25 tons, brought from Ovifak, Disco, Greenland, by Professor A. E. Nordenskjold, and specimens of Kryskonite from the inland Ice of Greenland, thirty miles from the edge, and 2,000 feet above the sea; brought home by Professor Nordenskjold.

B. B. Labrey, Esq., *Didsbury, Manchester*:—Some insects preserved in spirits. and a few foreign Lepidoptera.

E. M. Cosgrave, Esq., *Eccles-street*:—A few specimens of British Lepidoptera.

George Williams, Esq., 5, *Charleston-road, Rathmines*:—A Sea-snake (*Pelamis bicolor*) captured in the Indian Ocean 200 miles from land.

J. Walsh, Esq., R. N., *Albany Cottage, Rathgar*:—Bow and Arrows from Tanna, one of the New Hebrides. Arrows from the Island of Erromango; and model of a canoe with outrigger, from Byron Island.

Gilbert Sanders, Esq., *Monkstown*:—*Mactra helvacea* from Hayle Sands, Cornwall, and some specimens of *Paludina vivipara* from London.

Alexander Carte, M. D., F. L. S., *Director*.

INTELLIGENCE.

ROYAL DUBLIN SOCIETY'S SCHOOL OF ART.

THE DISTRIBUTION OF PRIZES.

THE distribution of Prizes to the successful Pupils in the Royal Dublin Society's School of Art, during the past Session, took place last evening, in the Theatre of the Society House, Kildare-street, in presence of the Lord Lieutenant, the Countess Spencer, and a large assemblage of ladies and gentlemen. Their Excellencies—who were accompanied by Lord Dufferin, and Lord Charles Bruce, and attended by Captain Brydges, A. D. C., Captain Finch, A. D. C., and Mr. Courtenay Boyle—arrived shortly after nine o'clock, and were received at the outer entrance by the Members of the Fine Arts Committee, by whom they were conducted to the Hall, where the Lord Lieutenant took the presidential chair.

Mr. GEO. JOHNSTONE STONEY, *Secretary*, said the Society felt highly honoured in having His Excellency in the presidential chair that evening, not so much because of his being the representative of the Queen, or because of his high position, but in consequence of the deep and enlightened sense of the real scope of Art of which he had always given evidence in speeches made by him at former meetings, and on various other occasions. His Excellency's reputation as a patron of Art had preceded him to Ireland. He remarked for himself, when a lad, the new intellectual day which had arisen to him from the lectures of Sir Joshua Reynolds—addresses which not only afforded a larger standpoint of judgment in matters of Art proper, but also furnished canons for forming correct judgment in respect to other spheres of human thought, whether in literature or science, This, however, required to be furthered by practical study, and in this latter regard they were greatly indebted to His Excellency for his valuable loan contributions to the National Gallery, which greatly added to the means of instruction at the command of the Students. Regarding the success of their Institution, he need only refer to the testimony of Mr. Cole, who had, perhaps, a larger experience than any other man living on the subject, and who stated that, in his opinion, they would, as a School of Design, compare with the celebrated Parisian Academy if brought into open and fair competition. Indeed, their prosperity hitherto gave every reason for believing in a golden future. One of the things in which they were deficient was a sufficient and adequate measure of Industrial Art. The specimens which Dublin Pupils had an opportunity of studying were but few, and of limited scope. If this *desideratum* were overcome he was assured their success would be very much greater. Another thing to which he might refer was the paucity of Prizes offered from private sources to their Schools. In the present year they had—and they did it right heartily—to thank four manufacturers for having assisted them in that way—Messrs. Peter Sheridan, Thomas Leetch, and Thomas Walker, of this city; and Mr. John Browne, of Belfast, in which latter town a kindred Institution was much more liberally supported. There was another circumstance which very much militated against the Dublin School, and in spite of which it had attained ts present prosperity—the system which obliged their Students entering the list for third-ilass Certificates to go for examination to London. True, those who were successful get their expenses paid by the Department; but, even then they were at a disadvantage with those who resided on the other side of the water, seeing that all who went across could not be successful. What he would suggest in place of this course was the sending hither of a competent inspector, which would still preserve the idea of centralization, which they did not dread, but rather courted, and which would put them more on anequality with South Kensington Pupils. Having referred to the death of Mr.

Watkins, and other former Pupils of the School, Mr. Stoney concluded by hoping that at the close of the current year they would be enabled to point to similar progress.

Dr. Evory Kennedy, Chairman of the Fine Art Committee, submitted the Annual Report, as follows:—

HEAD MASTER'S REPORT FOR THE YEAR 1871.

To the Chairman and Members of the Fine Arts Committee.

Gentlemen,

In making my Report on the state and progress of the Schools of Art of the Royal Dublin Society, I beg to refer, in the first place, to the growing interest displayed by students of all classes in those branches of Art-Education that are more immediately connected with manufactures.

During the past year much time and attention have been devoted to such studies, and I have much pleasure in stating that many of our students, both male and female, have attained to great proficiency therein.

The recent exhibition of students' works in the School of Art exemplified the tendency of the systematic and well-considered system of instruction now in operation to produce drawings calculated to operate favourably on the various branches of manufacture of Ireland, and we may not unreasonably hope that, as persons qualified to become designers worthy of the name increase, new branches of manufacture may spring up.

The studies generally executed in the School during the year have been very satisfactory, and in many of the stages great advances have been made.

The study of the human form, both from the antique and the life, has received much attention, and the gentleman's class for the study of the nude-male model was largely attended. It is gratifying to find that the numbers of those qualified to enter upon the study of the living figure continues steadily to increase. It is to be regretted that many students possessed of much ability are, from want of means, unable to continue their studies sufficiently long to enable them to acquire that complete education in Art so essential in order to its due promotion in this country. Money Prizes more largely offered by manufacturers and others would tend very much to enable such students to devote a longer period to the study of Art than they are at present able to do.

During the past year the number of students attending the School has been 415, of which number 218 were males and 197 females.

The total number of artizan students attending amounted to 280, of which number 175 were males and 105 females.

The total amount of fees was £447 9*s.* 1*d.*

The maximum of attendance took place in the month of December, and was smallest in the month of July.

The total number of attendances during the year has been 25,311.

The following is an analysis of the occupations of students or their parents:—

Tradesmen,	101
Professional,	77
Artists and Art Teachers,	71
Merchants and Salesmen,	57
Civil Servants,	31
Landed Proprietors,	35
Unclassed,	43
Total,	415

The Local Examinations of the second grade took place on the 1st and 2nd days of May, in the evening, when 182 students, 107 males and 75 females, presented themselves for examination in the various subjects—viz., Freehand Drawing, Model Drawing, Practical Geometry, and Linear Perspective.

The Table appended shows the relative success of the male and female students in the

four subjects of examination; the number of exercises "Passed," for which Certificate Cards are given, and the number of papers "Excellent," and for which prizes are awarded.

The total number of Exercises passed was 114.

By Male Students.

	Freehand.	Geometry.	Perspective.	Model Drawing.	Total.
Passed,	20	6	4	17	47
Excellent,	8	3	2	1	9
Totals,	28	9	6	18	56

By Female Students.

	Freehand.	Geometry.	Perspective.	Model Drawing.	Total.
Passed,	27	7	2	9	45
Excellent,	1	5	4	3	13
Totals,	28	12	6	12	58

In comparing these results with those of former years it should be borne in mind that each year's standard has been raised, and this year considerably so in some of the subjects of study.

To each exercise passing Excellent a prize is awarded, but two or more prizes gained by the same student are represented by one award.

The following students are worthy of honourable mention in this Report, as having each passed in the whole of the four subjects of Examination on the occasion, viz.:—Mr. Thos. R. Scott and Miss Mary Weld, whilst the following are deserving of much commendation, as having each passed in three of the subjects, viz.: Mr. John Ritchie, Mr. Marcus Ruddle, Miss Mary Oliver, Miss Alicia Archdall.

This Examination, consisting entirely of time exercises of one hour each, has for its object the testing of the ability of the student in elementary work, and such as is the whole groundwork for advanced study in every department of Art. It is gratifying to find that students are becoming more and more impressed with the conviction that those higher results can never be worthily attained to but by the careful and patient mastery of the elements of Art.

The following gentlemen, members of the Council and of the Fine Arts Committee, attended during the Examination:—Evory Kennedy, Esq., M. D., Lieut.-Col. Adamson, John R. D'Olier, Esq., Professor Robert Ball, J. Dubedat, Esq., David Routledge, Esq., John Adair, Esq., Thos. A. Jones, Esq., P. R. H. A., and Dr. Wm. Barker.

Captain Dunsford, R. E., Deputy-Inspector, was also present.

In April the Works of the Students, in Painting, Drawing, and Modelling, were forwarded to the South Kensington Museum, to compete for National and other medals, as follows:—

In the Elementary Section, ...	63 Works.
In the Advanced Section, ...	118 Works.
Class Drawings, consisting of Geometry, Perspective, Projection, Models, Ornament, Figure, &c., . . .	494 Works.
Total,	675

To the works competing for the highest prizes or those of the 3rd grade, 27 awards were made to 25 students.

The following Table represents the position occupied by the Dublin School, as re-

gards these Prizes, as compared with the most considerable Art Schools of the United Kingdom:—

	No. of Students.	No. of Awards.
South Kensington,	954	80
Dublin,	415	27 to 25 students.
Manchester,	853	25
Leeds,	687	26
Nottingham,	520	23
Edinburgh,	640	22
Birmingham,	1045	18
Liverpool,	794	18
Glasgow,	1052	10

Of the works in the Advanced Section 37 were selected to enter into the National Competition. A list of the various works distinguished in the National Competition, in the competition for the prizes of the highest grade or National Awards, selections for National Competition, &c., will be found in the list of distribution.

The examiners of the works competing for National Awards were—Sir M. D. Wyatt; C. W. Cope, R. A.; R. Westmacott, R. A.; R. Redgrave, R. A.; F. R. Pickersgill, R. A.; J. C. Hortlsey, R. A.; H. A. Bowler, Esq.; and J. H. Pollen, Esq.

The examiners in reporting on the works forwarded from the Society's School, state —"On the whole this School gives evidence of much enterprise, and a desire to excel in most of the branches of instruction afforded by a School of Art."

36 Works in the higher stages of Art Instruction, executed by students of this School, were forwarded to the London International Exhibition, in February last, and are referred to most favourably in the Official Report. A description of these, together with the names of those students by whom executed, will also be found appended to this Report.

Miss M. A. M'Gee proceeded to London, there to undergo an examination for the first Certificate of the Third Grade (Elementary Drawing and Colouring), and succeeded in obtaining the same.

In July last, the Lords of the Committee of Council on Education offered prizes for the best designs for Fans, to be competed for by students of Schools of Art throughout the United Kingdom. Miss Mary Anne M'Gee succeeded in gaining one of the prizes offered, for a very excellent Fan design, which has since been purchased by the Department of Science and Art, and was also selected for the London International Exhibition.

In the last Report of the Department of Science and Art, the gratifying success of the School is referred to, and also the high appreciation of the examiners of the designs therein executed.

During the past year the following manufacturers have offered money prizes to our students, viz.—Mr. James Walker, of Crow-street, Dublin; Mr. Peter Sheridan, of Parliament-street, Dublin; Mr. Thomas Leetch, of Dame-street, Dublin; and Mr. John S. Brown, of Belfast; and I am happy to report that the works executed in competition by our students for these prizes have given great satisfaction to these gentlemen.

The offer of such prizes affords most satisfactory evidence of the way in which these Schools are acting upon the manufactures of the country.

Mr. Edward T. Dresden offers to male and female students of the Schools of Art the following Prizes for a Dessert Service:—

A First Prize of . .	£15
A Second Prize of .	„ 10
A Third Prize of . .	5

The designs must consist of Full-sized Coloured Drawings of a Centre-piece, a Compotica, and a Plate. The works to be submitted in competition on the 9th of April, 1872.

In March last the Honorary Professor of Fine Arts, Henry M'Manus, Esq., delivered two lectures on "The Analysis of a Picture," which was attended by 261 persons.

The Honorary Professor of Artistic Anatomy, Alexander Macalister, M. D., delivered a course of six lectures on Anatomy, in its application to the Fine Arts, which were attended by 608 persons. At the conclusion of the course an examination was held, and a First and two Second Silver Medals awarded to students of the School of Art.

The competition for the Bronze and Silver Medals offered by the Royal Dublin Society took place on the 22nd of December, the examiners upon that occasion being—Sir George Hodson, Bart.; Thomas Alfred Jones, Esq., P. R. H. A.; Joseph Kirk, Esq., R. H. A.; Thomas N. Deane, Esq., R. H. A.; and Henry Doyle, Esq., Director of the National Gallery, Ireland.

Eyre Crow, Esq., the Inspector of the Science and Art Department, visited the School on the 17th January, 1871.

At the recent Exhibition of Students' Works, open from the 26th of December to the 6th of January, 1872, the visitors numbered 6420, amongst whom were His Excellency the Lord Lieutenant and the Countess Spencer.

An additional class has been recently established, viz., an Evening Class for Female Pupils. This class, meeting three nights per week, from half-past six to half-past eight o'clock, is likely to prove of great advantage to those whose occupations requiring a knowledge of drawing prevent their devoting any portion of the day to its study.

I have also to refer to another arrangement, by which pupils of schools, and those employed in workshops, can attend the Male or Female Evening Classes, at reduced fees, viz., one shilling per month, or four shillings per session of five months, provided that six students enter from any one school or establishment. The great importance of a course of Art Study, and the acquisition of a correct taste to all those who are engaged in operations of every kind, more particularly those of a decorative character, cannot be over-estimated, and it is evident that workmen and employers are becoming more convinced of its necessity, tending as it does so largely to their material prosperity.

Two young artists of great ability and promise, educated in the Society's Schools, have, during the past year, been removed by death from amongst us; I refer to Mr. Roderick O'Farrell, and Mr. Joseph Watkins.

I have to acknowledge the valuable assistance rendered by Miss Mary Julyan, in the instruction of the female classes, and the great ability displayed by that lady in the discharge of her duties.

My best thanks are also due to my assistants, Mr. Edmond Ribton Byrne, Mr. William H. Murray, Mr. Robert Walsh, and Mr. Robert Sidney Smith, for their zealous endeavours and co-operation with me in carrying out the objects of the School.

In concluding this Report it may not be out of place to remark upon the growing necessity for the more extensive application of Art to the requirements of the age in which we live, rendering it desirable that all engaged in industrial pursuits and operations, especially those that are obviously dependent for success upon a cultivated taste and artistic ability, should realize the importance of acquiring a much more complete knowledge of the bearing of Art upon industrial labours than has hitherto been considered necessary. The continually increasing taste of the public demands more and more, on the part of manufacturers and producers of every kind, increased beauty of form, together with skilful and original treatment, not only in all articles of luxury, but also in common objects of daily use. In order to render these things more beautiful and pleasing to contemplate, how desirable that all concerned in their production should appreciate elegant form, beauty of line, and graceful contour; and it cannot be too frequently reiterated that in order to form a true and pure taste, and such as may have the greatest influence in promoting manufacturing design and elevating it in the highest degree, it is necessary to become familiar with the merits and beauties of all styles that have prevailed in the world's history; for incalculable benefits must result from the consideration and investigation of those *chef d'œuvres* of the great ornamentists of past periods, so replete with instruction. The conscientious examination of such productions, when considered with the light derived from the study of Nature, leads to the conviction that they are the result of profound knowledge of the resources of Art, arrived at, even by men of genius, only after long study.

If our modern productions, in which industry is associated with Art, are to approach

to the perfection of these inestimable treasures of former times, our artizans and all concerned must devote themselves more earnestly to the study of Art, and exercise more largely the inventive faculty, for it is not by the servile imitation and reproduction of the old types that we can make any real progress.

The education of the eye tends to make Nature every man's possession, and enables him to derive pleasure from dwelling upon the beauties and harmonies of the world around him, thus inspiring him with a higher degree of veneration for the Creator of all, and by diverting his mind from the narrow circle in which he habitually moves, with its responsibilities and sordid cares, his happiness is increased and his mind elevated and purified. In this way the study of Art, by cultivating the intelligence, refining and purifying the sentiment, and elevating the taste, will lead to a higher development in every industry—to new, harmonious, and graceful creations and combinations, such as may serve as worthy records of our times to future generations.

Gentlemen, I have the honour to remain,
Your obedient Servant,

(Signed) R. Edwin Lyne, *Head Master.*

He (Dr. Kennedy) said that for all the success which the Report evinced they were greatly indebted to their excellent Master, Mr. Lyne, of whom Mr. Henry Cole had made flattering mention in his criticism of that and kindred Schools. It was a proud thing to know that they, although labouring under enormous disadvantages, had taken the second highest number of awards proportionately to the number of students, being beaten only by Manchester, and beating South Kensington, Leeds, Nottingham, Edinburgh, Birmingham, Liverpool, and Glasgow. Daily their designs were being more extensively sought after, and only since entering that Hall he had received intimation that the great house of Wedgewood had adopted their designs, and were carrying some of them into execution. He hesitated not to assert that, if placed on an equality with London and Edinburgh pupils, they would excel every School in Great Britain. And why was it that what had been so frequently demanded had not been granted? Why was it that they had no Museum, and £3,000 less in the year than Scotland, for instance, for the purpose of furthering Art Studies? Simply because our Members of Parliament were negligent of their duty. If they but united, with the assistance of his Excellency and the Marquis of Hartington, which, he doubted not, would always be forthcoming, they must succeed in overcoming the scruples of that excellent and liberal man, the Chancellor of the Exchequer. He hoped this would be attempted ere long, and that before they next assembled something would have been done towards establishing a Fine Art Museum in Ireland.

REPORT OF THE JUDGES APPOINTED TO EXAMINE THE WORKS SUBMITTED BY THE STUDENTS IN THE SCHOOLS OF ART OF THE ROYAL DUBLIN SOCIETY, CHRISTMAS, 1871.

We have carefully examined the productions of the Art Students in the Schools of the Society for 1871, and unanimously record our approval of the specimens submitted for our inspection, many of which give evidence in a remarkable degree of patient study, combined with the exercise of tasteful invention, more particularly in the valuable department of Art as connected with manufactures.

We are unable to make any award of a silver medal for Art Teachers, the only drawing of the "Germanicus," submitted by Mr. Robert Walshe, being in a very unfinished state.

Much promise being evinced in the bust from life by Mr. Robert S. Smith, we think the Silver Medal so lapsed might, with propriety, be awarded to this student;

and we think that a similar distinction might justly be extended to Mr. Edward Ribton Byrne, for his excellent sketches from nature in oil.

CLASS I.—*Studies of the Human Figure.*

Names.	Prizes.
Miss Edith Arnold, Study of Full Length Antique Figure,	*First Silver Medal.*
Miss Anna Parnell, Study of Head painted from Life,	*First Silver Medal.*
Miss Phœbe Anne Moss, ditto,	*Highly Commended.*
Miss Phœbe Anne Moss, Chalk Drawing from the Antique—Head, Hand, and Foot,	*Second Silver Medal.*
Miss Alice Lee, ditto (recommended),	*Bronze Medal.*
[The entire of the Drawings in this Section are deserving of commendation].	
Miss Kate O'Brien, Model in Clay from Life,	*First Silver Medal.*
[Miss Kate O'Brien's two studies display such marked excellence that we award her the First Silver Medal, notwithstanding the unfinished state in which they are presented].	
Mr. Edward Bestick, Model in Clay from Life or Antique (recommended),	*Bronze Medal.*
Mr. James Neville, Head of Son of Laocoon,	*Favourable Mention.*
Miss Jane Garbois, Anatomical Study,	*Second Silver Medal.*
Miss Jeanie Conan, ditto,	*Favourable Mention.*
Miss Mary Weld, outline of Figure from the Flat, Farnese Hercules,	*Bronze Medal.*
Mr Thomas E. Seadon, ditto, Laocoon,	*Honorable Mention.*

CLASS II.—*Design for Manufactures.*

Miss Elizabeth Irwin, Design for Carpet,	*First Silver Medal,*
Also the Prize of two guineas offered by Mr. Sheridan.	
Miss Bridget M'Gloine, ditto,	*Bronze Medal.*
And a Prize of one guinea offered by Mr. Sheridan.	
Miss Elizabeth Irwin, Ceiling Decoration,	*Silver Medal.*
Miss Frances Brett, ditto,	*Bronze Medal.*
Miss Isabella Bergin, Wall Decoration,	*Bronze Medal.*
Miss Phœbe Anne Moss, Fan Design,	*Bronze Medal.*
Miss Frances Brett, ditto,	*Honorable Mention.*
Miss Emily Lees, ditto,	*Honorable Mention.*
Miss Elizabeth Irwin, ditto,	*Honorable Mention.*
Miss Maria D. Webb, Muslins,	*Bronze Medal.*
Miss Mary Anne Magee, Damask,	*Silver Medal.*
And Mr. John Brown's Prize of £5.	
Mr. John Thomas Miles,	*Second Bronze Medal.*
And Mr. Brown's Prize of £3.	
Miss Elizabeth Irwin,	*Third Bronze Medal.*
And Mr. Brown's Prize of £2.	
Miss Frances Brett, Plate Designs,	*First Silver Medal.*
And Prize of Three Guineas offered by Mr. Thomas Leetch, Dame-street.	
Miss Elizabeth F. Bredin, Plate Design,	*Bronze Medal.*
And Prize of Two Guineas offered by Mr. Edward Leetch, Dame-street.	

CLASS III.—*Architecture and Machine Drawing.*

Mr. James Boucher, Public Building,	*First Silver Medal.*
Mr. Anthony Scott, Geometry,	*Bronze Medal.*
Miss Mary Anne McGee, Perspective,	*Bronze Medal.*
Mr. John Beardwood, Projection,	*Bronze Medal.*

Names.	Prizes.
CLASS IV.—*Groups in Oil or Water Colours.*	
Miss Henrietta Wise, Group in Oil,	*First Silver Medal.*
Miss Olivia Poole, ditto,	*Honorable Mention.*
Miss Isabella Bergin, Best Group in Chalk,	*Bronze Medal.*
Miss Eleanor Kerr, ditto,	*Bronze Medal.*

CLASS V.—*Landscapes in Oil or Water Colours.*

Miss Isabella Maffet, Landscape in Water Colour,	*Second Silver Medal.*
Miss Maria D. Webb, ditto, Oil (recommended),	*Bronze Medal.*
Miss Mary Anne Morgan, Landscape in Water (recommended),	*Bronze Medal.*
Miss Josephine Carson, Flowers or Foliage from Nature,	*Bronze Medal.*
Miss Mary Anne McGee, Sheet of Fruit from Nature, in Water Color,	*Second Silver Medal*
Miss Elizabeth Wallace, ditto,	*Honorable Mention.*
Miss Francis Seymour, ditto,	*Bronze Medal.*

CLASS VI.—*Ornament from the Flat and Round.*

Miss Archdall, Ornament in Outline,	*Bronze Medal.*
Miss Harriett Thornhill, ditto shaded,	*Bronze Medal.*
Miss Susan Ball, Ornament shaded from Round,	*Bronze Medal.*
Miss Mary F. Murphy, Ornament in Outline from Round,	*Bronze Medal.*

In concluding our Report we desire to express our unanimous recognition of the valuable results that have attended the anxious and painstaking attention in the discharge of his duties on the part of Edwin Lyne, Esq., to whose unremitting exertions may be fairly ascribed the proficiency attained in these Schools of Art, observable on this as well as on former occasions.

(Signed) GEORGE HODSON, BART.
THOMAS A. JONES, *President* R. H. A.
HENRY DOYLE, *Director National Gallery.*
JOSEPH R. KIRK, R. H. A.
THOMAS N. DEANE, R. H. A.

December 27, 1871.

EXAMINATION IN ARTISTIC ANATOMY.

First Prize.

Miss Kate J. O'Brien,	79

Second Prize.

Miss Elizabeth Robie,	} 71
Mr. Robert Smith,	} 71
Miss Mary A. Chaytor,	65
Miss Anna Parnell,	61
Miss Olivia Poole,	58
Miss Elizabeth Naylor,	53
Miss Harriette Thornhill,	41

ALEX. MACALISTER.

LIST OF MEDALS AWARDED BY THE JUDGES,

December 22, 1871.

Special Silver Medals.

Names.	Prizes.
Robert Sidney Smith, Model in Clay from the Life,	*Special Silver Medal.*
Edmund Ribton Byrne, Landscape in Oil from Nature,	*Special Silver Medal.*

Class I.

Miss Edith Arnold, Drawing from the Antique in Chalk, full length (Milo Venus),	*First Silver Medal.*
Miss Anna Parnell, Painting Head from the Life in Oil,	*First Silver Medal.*
Miss Phœbe Anne Moss, Painting Head from the Life in Oil,	*Honorable Mention.*
Miss Phœbe Anne Moss, Head, Hand, and Foot from Antique in Chalk,	*Second Silver Medal.*
Miss Alice Lee, Head, Hand, and Foot, from the Antique in Chalk,	*Bronze Medal recommended.*
Miss Kate Josephine O'Brien, Models from the Life in Clay,	*First Silver Medal.*
Mr. Edward Bestick, Model in Clay from the Antique,	*Bronze Medal.*
Mr. James Neville, Model in Clay from the Antique,	*Honorable Mention.*
Miss Jane Garbois, Anatomical Study,	*Second Silver Medal.*
Miss Jeanie Conan, Anatomical Study,	*Honorable Mention.*
Miss Mary Weld, Outline of Human Figure from the Flat (enlarged),	*Bronze Medal.*
Mr. Thomas Seadon, Outline of Human Figure from the Flat (enlarged),	*Honorable Mention.*

Class II.

Miss Elizabeth Irwin, Original Design for a Carpet,	*First Silver Medal.*
Miss Bridget M'Gloine, Original Design for a Carpet,	*Bronze Medal.*
Miss Elizabeth Irwin, Original Design for Stucco Ceiling,	*Second Silver Medal.*
Miss Frances Brett, Original Design for Stucco Ceiling,	*Bronze Medal.*
Miss Isabella Bergin, Original Design, Wall Decoration,	*Bronze Medal recommended.*
Miss Phœbe Anne Moss, Original Fan Design,	*Bronze Medal.*
Miss Frances Brett, Original Fan Design,	*Honorable Mention.*
Miss Emily Lees, Original Fan Design,	*Honorable Mention.*
Miss Elizabeth Irwin, Original Fan Design,	*Honorable Mention.*
Miss Maria Dorothea Webb, Original Design for Muslins,	*Bronze Medal.*
Miss Mary Anne Magee, Original Design for Table Damask,	*First Silver Medal.*
Mr. John Thomas Miles, Original Design for Table Damask,	*Bronze Medal.*
Miss Elizabeth Irwin, Original Design for Table Damask,	*Bronze Medal.*
Miss Frances Brett, Original Designs for Plates,	*First Silver Medal.*
Miss Elizabeth Bredin, Original Designs for Plates,	*Bronze Medal.*

Class III.

Mr. James Boucher, Public Building from Actual Measurement,	*First Silver Medal.*
Mr. Anthony Scott, Practical Geometry,	*Bronze Medal.*
Miss Mary Anne M'Gee, Linear Perspective,	*Bronze Medal.*
Mr. John Beardwood, Orthographic Projection,	*Bronze Medal.*

CLASS IV.

Names.	Prizes.
Miss Henrietta Wise, Group in Oil,	*First Silver Medal.*
Miss Olivia Poole, Group in Oil,	*Honorable Mention.*
Miss Isabella Bergin, Group in Chalk,	*Bronze Medal.*
Miss Eleanor Kerr, Group in Chalk,	*Bronze Medal.*

CLASS V.

Miss Isabella Maffett, Landscape from Nature in Water Colour,	*Second Silver Medal.*
Miss Maria Dorothea Webb, Landscape from Nature in Oil,	*Bronze Medal.*
Miss Mary Anne Morgan, Landscape from Nature in Water,	*Bronze Medal.*
Miss Josephine Carson, Foliage from Nature in Outline,	*Bronze Medal.*
Miss Mary Anne M'Gee, Fruit painted from Nature, in Water Colour (Pear Branch),	*Second Silver Medal.*
Miss Elizabeth Wallace, Fruit painted from Nature, in Water Colour (Vine Branch),	*Honorable Mention.*
Miss Frances Seymour, Fruit painted from Nature, in Water Colour (Apple Branch),	*Honorable Mention.*

CLASS VI.

Miss Alice Archdall, Outline of Ornament from the Flat (enlarged),	*Bronze Medal.*
Miss Harriett Thornhill, Ornament Shaded from the Flat (Chalk),	*Bronze Medal.*
Miss Susan Ball, Ornament Shaded from the Round (Chalk),	*Bronze Medal.*
Miss Mary F. Murphy, Ornament in Outline from the Round,	*Bronze Medal.*

	11	*First Silver Medals.*
	7	*Second Silver Medals.*
	23	*Bronze Medals.*
Total,	41	Medals.

ARTISTIC ANATOMY.

Miss Kate O'Brien,	*1st Silver Medal.*
Miss Elizabeth Robie,	*2nd Silver Medal*
Mr. Kobert S. Smith,	*2nd Silver Medal*

MONEY PRIZES OFFERED BY MANUFACTURERS.

FOR TABLE DAMASKS, BY JOHN BROWN, ESQ., OF BELFAST.

1st Prize to Miss Mary Anne Magee,	£5 0 0
2nd Prize to Mr. John Thomas Miles,	3 0 0
3rd Prize to Miss Elizabeth Irwin,	2 0 0

FOR CARPETS, BY PETER SHERIDAN, ESQ., OF PARLIAMENT-STREET, DUBLIN.

1st Prize to Miss Elizabeth Irwin,	2 Guineas.
2nd Prize to Miss Bridget M'Gloin,	1 Guinea.

FOR PLATES, OFFERED BY THOMAS LEETCH, ESQ., OF DAME-STREET, DUBLIN.

1st Prize to Miss Frances Brett,	3 Guineas.
2nd Prize to Miss Elizabeth F. Bredin,	2 Guineas.

FOR ALMANACK, OFFERED BY THOMAS WALKER, ESQ., CROW-STREET, DUBLIN.

1st Prize to Mr. H. M'Connell,	£5 0 0
2nd Prize to Miss Marcella Irwin,	2 10 0
3rd Prize to Mr. John Burnside,	2 10 0

NATIONAL AWARDS, 1871.

Name of Student.	Stage.	Description of Work.	Award.
Smith, Robert Sidney, ...	19*d*	Boy's Head, Modelled from the Life in Clay,. . . .	Bronze Medal.
Bestick, Edward, .	19*b*	Head of Apollo, Modelled from the Antique, . . .	Bronze Medal.
Moss, Phœbe Anne,	8*b*1	Drawing from the Antique in Chalk, ...	Prize Book.
Seymour, Kate, .	17*b*	Study of a Male Figure from the Life in Oil, ...	Prize Book.
Gibson, Edward, .	19*b*	Study Modelled in Clay (low relief), Bust of Milo Venus,	Prize Book.

SELECTIONS FOR NATIONAL COMPETITION.

Students' Names.	Stage.	No. of Works	Subject.
Brett, Frances M., .	23*d*	1	Original Design for Ceiling Decoration in Stucco.
Benson, Ismena Sarah .	8*b*(1)	1	Bust of Niobe, shaded in Chalk.
Boyle, J. T., . .	23*d*	1	Original Design for a Mirror Frame.
Byrne, Edmund Ribton.	8*b*(2)	1	Discobolus, shaded in Chalk.
Evans, Julia, . .	19*b*	1	Model in Clay of Clytic, reduced from the Antique.
Gibson, Edward, . .	19*b*	2	Model in Clay, from the Antique (Bust of Milo Venus). Low Relief.
Irwin, Marcella, . .	23*c*	1	Original Design for Ceiling Decoration in Stucco.
Irwin, Elizabeth, . .	23*d*	1	Original Design for Ceiling Decoration in Stucco.
Garbois, Jane N., . .	9*a*	2	Two Views of the Skull—Water Colour Studies. Study of Skeleton in Water Colour.
Jordan, Frances Lydia,	23*c*	2	Original Design for Wall Decoration. Original Design for Wall Decoration.
Murray, William Henry,	23*c*	1	Original Design for Wall Decoration.
M'Donnell, James, .	14*b*, 17*b*	2	Landscape of Irish Scenery in Oil Colour. Female Head from Life in Oil.
Maffett, Isabella, . .	14*b*, 8*b*(2), 8*d*	3	Landscape of Irish Scenery in Water Colour (6 Works). Study of a Female Head in Chalk from the Life. Study from the Antique in Chalk (Milo Venus).
Morgan, Marianne, .	8*b*, 14*b*	2	Studies in Chalk of Hand and Foot from Antique. Landscape of Irish Scenery in Water Colour.
M'Gloyne, Bridget, .	23*c*	1	Original Design for Carpet.
Moss, Phœbe Anne, .	8*b*(1), 17*b*	3	Hand in Chalk from the Antique. Foot in Chalk from the Antique. Study in Oil from the Life, Female Head.
Parnell, Anna, . .	8*b*(1), 17*b*	2	Foot of the Laocoon from the Antique in Chalk. Italian Boy's Head from the Life in Oil Colour.
Reilly, Sylvester, . .	23*c*	1	Original Design for a Book Cover.
Smith, Robert Sidney, .	19*d*	1	Model in Clay from the Life of Head of a Boy.
Walsh, Robert F., .	8*b*(2)	1	Study from the Antique in Chalk of Antinous.
Webb, Maria D., . .	17*b*, 23*c*	2	Study in Oil from the Life, Head of Italian Boy. Four Original Designs for Muslins.
O'Brien, Kate, . .	19*b*	1	Model in Clay of Farnese Hercules.
Lee, Alice, . . .	8*b*(1)	1	Study in Chalk from the Antique of Head of Ajax with helmet.
Seymour, Kate, .	17*b*	1	Study in Oil from the Life, Italian Boy, full length.
Seymour, Frances, .	14*a*	1	Study from Nature of Apple Branch in Water Colour.
Bestick, Edward, . .	19*b*	1	Model in Clay from the Antique, Head of Apollo.

THIRD GRADE PRIZES.

Highest Prize is marked (P 2).

Students' Names.	Prize.	Stage.	No. of Works.	Subject.
Adams, Walter, .	P 1	6*a*	1	Hercules enlarged from the Flat.
Ansell, Alice, .	P 1	2*b*	1	Tarsia or Wood Mosaic enlarged from the Flat.
Boyle, J. T., .	P 2	23*d*	1	Design for Mirror Frame.
Bestick, Edward, .	P 2	19*b*	1	Model in Clay, Head of Apollo.
Byrne, Edmd. Ribton,	P 2	8*b*(2)	1	Study from the Antique in Chalk of Discobolus.
Evans, Julia E., .	P 2	19*b*	1	Model in Clay, Head of Clytie, reduced.
Fitzpatrick, Kate E., .	P 2	5*a*	1	Group of Models in Chalk from the Round.
Garbois, Jane N., .	P 2	9*a*	2	Anatomical Study, Skeleton. " " Skulls.
Gibson, Edward, .	P 2	19*b*	1	Model in Clay of Milo Venus. Low Relief.
Kerr, Eleanor, .	P 1	4*b*	1	Antique Column, Ivy Decoration, from the Flat in Chalk.
Miles, John Thomas, .	P 2	5*a*	1	Group of Models shaded in Chalk from the Round.
M'Donnell, James, .	P 2	14*b*	1	Landscape of Irish Scenery from Nature in Oil.
Maffett, Isabella, .	P 2	8*b*(2)	1	Milo Venus in Chalk from the Round.
Morgan, Marianne, .	P 2	8*b*(1)	1	Hand and Foot from the Antique in Chalk.
Moss, Phœbe Anne, .	P 2	8*b*(1)	1	Foot from the Antique in Chalk.
Oliver, Mary, .	P 2	5*a*	1	Group of Models shaded in Chalk.
Parnell, Anna, .	P 2	8*b*(1), 17*b*	2	Foot shaded in Chalk from the Antique. Study from the Life in Oil of Italian Boy.
Reilly, Sylvester, .	P 2	23*c*	1	Original Design for a Book Cover.
Smith, Robert Sidney,	P 2	19*d*	1	Model in Clay from the Life, Boy's Head.
Thornhill, Harriett, .	P 1	4*b*	1	Roman Car, shaded in Chalk from the Flat.
Wallace, Elizabeth, .	P 2	5*a*	1	Group of Models shaded in Chalk from the Round.
Withers, George W., .	P 2	5*a*	1	Group of Models shaded in Chalk from the Round.
Weld, Mary, .	P 1	6*a*	1	Hercules enlarged from the Flat (Outline).
Seymour, Frances, .	P 2	14*a*	1	Study of Apple Branch in Water Colours from Nature.
Irwin, Elizabeth, .	P 2	5*a*	1	Group of Models, shaded in Chalk from the Round.

SECOND GRADE PRIZES.

List of Students who have been successful.

Name.	Nature of Examination. Free-hand.	Geometry.	Perspective.	Model.	Prize Selected.	Full Certificate.
Boucher, Dudley W., .	P	..	..	P	..	Certificate.
Carson, Josephine E., .	..	..	E	..	Crayons.	Certificate.
Cellem, Mary Alice, .	..	E	..	..	Burchett's Geometry.	
Colles, Adelaide R., .	..	..	..	E	Cotman's Sepia Landscapes.	

P signifies Passed, and entitles the Student to a certificate Card. E signifies Excellent, and entitles the Student to a Prize.

Name.	Nature of Examination. Free-hand.	Geometry.	Perspective	Model.	Prize Selected.	Full Certificate.
Conan, Jeanie C., . .	..	P	..	E	Wornam's Ornament, and Lindley's Botany.	
Foster, Florence A., .	..	E	..	..	Burchett's Geometry.	
Griffin, George, . . .	..	..	..	P	..	Certificate.
Johnston, Joseph, . .	P	..	..	..	..	Certificate.
Keating, Henry, . .			E		Instruments.	Certificate.
Keatinge, Eleanor . .	E	..	..	..	Instruments.	
Kirkwood, Elizabeth, .	..	E	..	..	Burchett's Geometry.	
Magee, Mary A., . .	P	..	..	..	..	Certificate.
Milligan, William J.,	P	E	..	..	Burchett's Perspective	
Mitchinson, Caroline M.	P	..	..	E	Colours.	Certificate.
Moynan, Richard T., .	E	..	..	P	Colours.	
Mitchinson, Elizabeth,	..	E	..	..	Burchett's Perspective.	Certificate.
Mitchinson, Isabella, .	P	..	..	P	..	Certificate.
Murray, Albert E. . .	..	..	..	E	Cotman's Sepia Landscapes.	
Naylor, Elizabeth, . .	E	..	..	..	Burchett's Perspective.	
O'Hanlon, Julia, . .	..	P	..	..	..	Certificate.
Oldham, Eldrid, . .	E	..	..	P	Cotman's Sepia Landscape.	Certificate.
Oliver, Mary, . . .	P	..	P	E	Wornam's Ornaments and Lindley's Botany.	
Peart, Joseph H., . .	..	E	P	..	Burchett's Perspective.	
Ritchie, John, . . .	..	P	E	P	Colours.	
Scott, Thomas R., . .	E	P	P	P	Cotman's Sepia Landscapes.	Certificate.

P signifies Passed, and entitles the Student to a Certificate Card. E signifies Excellent, and entitles the Student to a Prize.

Name.	Nature of Examination.				Prize Selected.	Full Certificate.
		Geometry.	Perspective.	Model.		
Tighe, James H., . .	P	E	..	..	Burchett's Perspective.	
Weld, Mary J., . .	P	P	P	E	Burchett's Geometry and Perspective.	Certificate.
Wharton, Jane Julia A. W.	..	..	E	..	Cotman's Pencil Outlines.	
Withers, George G. W.,	..	..	..	P	..	Certificate.
Allen, Charles J. . .	..	..	..	P		
Archdall, Alicia, . .	P	P	P	..		
Armstrong, Lavinia E.,	P	..	P	..		
Atthell, Matilda J., .	P	..	..	..		
Buman, James, . .	P	..	..	..		
Byng, Ella E. N., . .	P	..	..	..		
Byrne, John H., . .	P	..	..	..		
Coffey, George, . . .	P	P	..	..		
Cope, Eleanor, . . .	P	..	..	..		
Cuthbert, Edward F., .	..	..	..	P		
Dillon, John G., . .	P	..	..	..		
Dolan, Annie M., . .	P	..	..	..		
Dundas, Olivia, . . .	..	P	..	..		
Geoghegan, Mary A., .	P	..	..	..		
Gernon, Vincent, . .	..	..	..	P		
Harrison, Charles, . .	P	..	..	..		
Hillier, Edith F., . .	P	..	..	P		
Holden, Thomas, . .	P	..	..	..		
Jacob, Geo. N., . . .	P	..	..	P		
Keane, Louisa C., . .	P	..	..	..		
Kerr, Eleanor, . . .	P	..	..	..		
Kenny, Robert H., . .	P	..	..	.		
Kirkwood, John, . .	..	P	..	..		
Kirkwood, Margaret, .	..	..	..	P		
Lyne, Florence C. H. .	P					

P signifies Passed, and entitles the Student to a Certificate Card. E signifies Excellent, and entitles the Student to a Prize.

Name.	Nature of Examination. Free-hand.	Geometry.	Perspective	Model.	Prize Selected.	Full Certificate.
M'Callum, Stephen, .	P	..	..	..		
M'Causland, Alice F. L.,	P	..	..	..		
Murphy, Marius, . .	..	P	..	P	..	
Naish, Fanny M., . .	..	P	..	..		
Nuttall, Georgina M., .	P	..	..	..		
O'Brien, Kate J., . .	..	..	..	P		
O'Brien, Robert D., .	P	..	..	..		
O'Byrne, John, . . .	P	..	..	..		
Onge, Emily, . . .	P	..	..	P		
Peart, Annie H., . .	P	..	..	..		
Peart, Mary L., . . .	P	..	..	..		
Poole, Olivia E., . .	P	..	..	..		
Ruddle, Marcus, . . .	P	..	P	P		
Seadon, William, . .	..	..	..	P		
Shaw, Geo., ...	..	P	..	P		
Sheridan, Vincent, . .	P	..	..	..		
Smith, Francis M., . .	P	..	..	..		
Stacpoole, Charlotte J.,	P	..	..	P		
Stokes, Stephen, . .	..	..	..	P		
Symes, Mary K., . .	P	..	..	..		
Symes, Penella, C., .	..	..	..	P		
Underhill, William, .	P	..	..	P		
Walker, Elizabeth E.,	P	..	..	..		
Walker, Frank, . .	P	..	..	..		
Walker, Janette. . .	..	P	..	..		
Warren, Mary H. G., .	..	P	..	..		
Waters, Thomas, . .	P	..	..	..		
Yeo, Robert F., . .	..	..	P	.		

P signifies Passed, and entitles the Student to a Certificate Card. E signifies Excellent, and entitles the Student to a Prize.

LIST OF WORKS EXHIBITED IN THE INTERNATIONAL EXHIBITION OF LONDON.

	Names of Students.
Carpet Design,	Miss Frances Brett,
Muslin Curtain Design,	Do.
Flowers painted from Nature, in Water Colour,	Miss Frances Seymour.
Muslin Designs (Dresses),	Miss Kate Seymour.
Group, in Oil Colours,	Miss Maria D. Webb.
Female Head, from Life, in Oil,	Do.
Group, in Oil,	Mr. Edm. Ribton Byrne.
Head from Life, in Oil,	Miss Kate Seymour.
Muslin Curtain Design,	Miss Elizabeth Irwin.
Group, in Oil,	Miss Phœbe Ann Moss.
Muslin Design (Dresses),	Miss Elizabeth Wallace.
Wall Decoration,	Miss Kate Seymour.
Female Head, from the Life, in Oil,	Do.
Design for Stucco, Wall Diaper,	Hon. E. Plunkett.
Model in Clay, from the Life Bust of a Girl,	Miss Kate J. O'Brien.
Model in Clay, of Head of Apollo,	Mr. Robt. Sidney Smith.
Group, in Oil,	Miss Elizabeth Smith.
Muslin Designs (Dresses),	Miss Fras. Lydia Jordan.
Do. Do.	Miss Ruth Nicholson.
Wall Decoration,	Miss Frances Brett.
Carpet Design,	Miss Marcella Irwin.
Poplin, manufactured by Messrs. Fry,	Miss Fras. Anna Ruxton.
Do. Do.	Mr. Henry Felix Thomas.
Do. Do.	Do.
Do. Do.	Do.
Tabinet, Do.	Miss Francis A. Ruxton.
Anatomical Study,	Mrs. Elizabeth Smith.
Study of Female Head, from Life, in Chalk,	Miss Maryanne Morgan.
Do. Do. in Oil Colour,	Miss Kate Seymour.
Do. Do. Do.	Do.
Design for Entrance Iron Gate,	Henry Hall.
Do. for Railway Truck,	Do.
Study, in Chalk, of Milo Venus,	Miss Elizabeth Smith.
Design for a Fan,	Miss Mary Ann M'Gee.
Model, in Clay, from the Life, Female Head,	Mr. William Millard.
Do. Boy's Head,	Mr. Joseph Watkins.

LIST OF LOANS MADE BY THE DEPARTMENT OF SCIENCE AND ART TO THE SCHOOL OF ART OF THE ROYAL DUBLIN SOCIETY.

Catalogue of Musical Instruments in the South Kensington Museum.
Catalogue of Lace and Embroidery in the South Kensington Museum.
Set of seventy-five Mechanical Drawings (hand made).
List of Art Objects lent to the Department during 1870.
List of Bequests and Donations to the South Kensington Museum.
List of Objects in the Art Division, South Kensington Museum.
Design for Silversmiths. 1 vol. Photographs.
Decorative Furniture, French. 1 vol. Photographs.
Decorative Furniture, English, Italian, German, Flemish, &c. 1 vol. Photographs.
First List of Buildings in England having Mural Decorations.

Landscape, with Bridge (Sunrise), Water Colour. David Cox.
Spanish Town, Torre dos Clericos (Water Colour). J. Holland.
Marine View (Oil), Fishing Boat entering Harbour. Jacobs, J.
Gipsy Encampment (Water Colour). David Cox.
Blackheath Windmill (Water Colour). E. W. Cooke, R. A.
Ruined Castle, Evening (Water Colour). J. Crome, Sen.
Life Study, Male (Chalk). Mulready.

The successful Students were then presented to His Excellency, from whose hands they each received the Prizes which were awarded to them.

Dr. Evory Kennedy proposed a vote of thanks to the Judges, coupling with the proposal the name of Mr. Jones, President of the Royal Hibernian Academy.

Mr. Jones said that, in the absence of Sir George Hodson, he had been unexpectedly called on to respond to the resolution that had just been proposed by the Chairman of the Fine Arts' Committee, and in terms of such commendation that they did not deserve, because their duty was an agreeable one—a labour of love; they worked very harmoniously, and whenever a difficulty arose it was because they had often to decide between nearly equal merits. He believed he only expressed the feelings of his brother Judges when he said that they found the arrangements of the School admirable, and the various drawings exhibited a most decided improvement over the works of last year. It was worthy of remark that the ladies had carried away most of the Prizes, as they had done in the Royal Academy, and it was a distinctive merit of this year's progress that there appeared to have been a speciality of talent for designs for manufactures. He could not avoid speaking with pleasure of the encouragement given to their School by the Prizes that were offered by manufacturers for designs.

Mr. George Woods Maunsell, in the absence of the senior Vice-President of the Society, proposed a vote of thanks to His Excellency the Lord Lieutenant for his kindness in presiding. In the course of his observations he remarked that there was a subject on which he had intended to say a few words; but in respect to which he had been anticipated by Dr. Kennedy, and that was the necessity which existed for a Museum of Ornamental Art, such as that which existed at South Kensington. He hoped that the Marquis of Hartington would be able to aid them in this matter, and that, in the coming year, somethiug might be done to bring this long-desired Institution in connexion with their School. He spoke with more confidence because he spoke in the presence of another member of Her Majesty's Government, the Earl of Dufferin, who had done much for the promotion of Art in the town of Belfast, and whose voice would not, he was certain, be wanted when their claim was set forth.

His Excellency the Lord Lieutenant then said:—Ladies and Gentlemen, I rise, I confess, to-night wtth mingled feelings of pleasure and embarrassment—pleasure, at receiving so kind a reception from this distinguished assembly, after a sojourn in this country for more than three years—embarrassment, at having, for the fourth time, to address you upon a subject in which, though I feel deeply interested, I am aware I can add very little new for your information. Let me first congratulate, as I have had the pleasure of doing before, the Royal Dublin Society on the success of its School of Art. I need not dwell on this subject, for we have heard it ably stated more than once during the course of this evening. It is very satisfactory to find that though, perhaps, this year the number of students has not been as numerous as on previous years, the excellence of the work done by them has exceeded what has been done before. It is also, I think, to the credit of this Society, and of this city, that though you have only half the number of students of South Kensington Museum, you have within five of the number of Prize-holders which that great School of Art produced. South Kensington had, I believe, 30 Prize-holders, and this Society in Dublin obtained 25 or 26 Prizes. Now, I think, that is eminently satisfactory, especially as I must admit that the Dublin students labour under some disadvantages when compared with those who attend the School in London. I fully admit that it is an enormous advantage to students to have a Museum, such as that which exists in London, to go there, and examine the very best examples that can be found, from all ages, of artistic works in every grade. There painters and sculptors, upholsterers,

designers of lace, decorators, or bookbinders, may go, and there they will find the highest examples of Art exhibited. They will not hav e to grope amongsta hundred bad specimens, but can at once find the best examples, selected by the best judges of each branch of Art. That, I think, is a great assistance to the students of that Museum. And now I come to a subject which has been referred to more than once. I do not at all quarrel with my friends, Dr. Kennedy or Mr. Maunsell, for alluding to it, for I know its vast importance. I refer to the subject of a Museum in Dublin. My friend, Lord Hartington, referred to this matter last year; and I regret very much that we were unable during last year to bring any complete measure before the Treasury, with the view of having such a School established in Dublin. Reference has been made to Scotland; but I do not wish to draw comparisons between England, Scotland, and Ireland. I am not sure that if I went into this matter, and totted up the sums given to the various scientific bodies, I should find that there was less given to Dublin than to Edinburgh. However, I do not wish to go into figures— I am not prepared to do so to-night—and I will only say that I am sure if we can only lay a good case before the Chancellor of the Exchequer—as I have no doubt we can— that although he has been represented as such a monster sitting over the Exchequer of England, he will assist in any good work for the promotion of high Art in this country as he would in England or in Scotland. The Report has been referred to which was drawn up by the Commission over which Lord Kildare so ably presided. That Report, I acknowledge, has not been acted upon, but I believe arrangements have already been made for further steps to be taken to see how the matter can be settled with regard to a Museum in Dublin; and I hope that in this year, before spring advances far, we may be able to come to some settlement on the matter; but I would point out that there have been some difficulties in it, for there are some very important bodies in this city who have charge of Collections of great importance, and we have to come to some arrangement with them, in order that the magnificent treasures under their care may be collected and form the nucleus of a Museum in this city. With their cordial co-operation I do not at all see that there would be any serious difficulty in establishing a Museum such as that in South Kensington. I would not say a word that would tend to destroy the individuality or usefulness of such an important body as this, or of the other bodies which have charge of artistic treasures, but I believe, with a judicious co-operation— and I am sure they would give their co-operation in any work of such importance to this country—we should be able to arrange some scheme whereby the Irish Schools would get a Museum for the advantage of their students. I will not dwell longer on the subject, but I assure you I will give my earnest attention to the matter, and I feel sure that when I invite any of the Societies represented here to co-operate in any plan we may have, thay will cordially come forward to assist us. Now, as to these Schools, I think that they have two objects, which, although they assist each other, are, to some extent, separate. You have a School of Design or Manufacture, and you have also a School of Education in Drawing and Sculpture. Mr. Jones, President of the Royal Hibernian Academy, has referred to the prominence shown among the students here for design. I believe that is very remarkable, and I think you should thank those manufacturers who have come forward and given their assistance. The Art Schools do much to bring out the genius of the country, and enable every person who has a taste for drawing and designing to acquire a knowledge of the Art. This knowledge really imparts great additional wealth to the country, for the manufactures of the United Kingdom, although always famous for fabric and workmanship, were not until recent years famous for their taste or design. These Art Schools have added greatly to the excellence of the designs, and in that way they have added materially to the wealth of the country. They also assist in another object; for although I know an Art School can only give the preliminary education necessary for high Art in drawing and sculpture, yet this one has already done much to bring out the genius and the talent of this city. It has furnished many pupils to the Royal Hibernian Academy, whose Exhibitions we hope to see next week, and at whose success I am sure every one here will join with me in heartily rejoicing. This School has, therefore, done much in this respect, and I am sure it will continue to do so. Allusion has been made to the distinguished artists removed during the past year from their career of prosperity and success.

No one laments more than I do the premature death of more than one of those artists who have been referred to. I think this Society has amongst it artists who will rise to eminence. The bust before us shows that the talent of one who has done much for Art in this country has been reproduced in his son. I wish Mr. Catterson Smith's son success in the career he has begun. I will, in conclusion, merely express a hope that that those students who have successfully begun to-night may persevere in their efforts, and by their perseverance add to the reputation of the Society and of the country which is so worthy of Art.

SPRING CATTLE SHOW, 1872.

This important National Exhibition took place on Tuesday, April 18, and three following days.

Stock was entered for Exhibition as follows:—

Short-horned Bulls,	Yearlings,	136	
,,	Other ages,	73—209	
,,	Heifers and Cows,		21
Hereford,	Bulls,		6
,,	Heifers and Cows,		6
Polled Angus,	Bulls,		4
,,	Heifers and Cows,		7
Devon,	Bulls,		6
,,	Cows and Heifers,		3
Kerry,	Bulls,		7
,,	Cows and Heifers,		30
West Highland,	Bull,		1
,,	Cows and Heifers,		2
Ayrshire	Bull,		-
,,	Cows and Heifers,		3
Channel Island Breeds,	Bulls,		4
,,	Cows and Heifers,		4
Of which there were of	Bulls,		238
,,	Cows and Heifers,		77
Fat Stock,			54
Swine Lots,			48
Total,			417
Implements and Machinery,			1224

The Show was very numerously attended, and was visited on Wednesday, 10th April, by His Excellency the Lord Lieutenant, who minutely examined every part of the Exhibition.

The Challenge Plate, now known as the Chaloner Plate, formerly the Irish Farmer's Gazette, and subsequently the Townley Cup, was won by Mr. Peake with his Devon Bull, Blood Royal, No. 248 in the Catalogue, the first occasion on these Shows that a Challenge Plate was awarded for an animal not of the short-horned breed.

The Banquet in connexion with the Show was given in the Board-room of the Society, and was honoured by the presence of His Excellency the Lord Lieutenant.

The chair was taken by George Woods Maunsell, Esq., D. L., one of the Vice-Presidents of the Society, who, in proposing the toast of "Her Majesty the Queen, the Patroness of the Royal Dublin Society," said that when gentlemen who were found of sufficient dignity to be placed in the senate of the country busied themselves about Her Majesty's domestic affairs, it might, perhaps be

not amiss to say one word. It was an idea of the most profound thinker of the last century—he meant their countryman Edmund Burke—that when any man was furiously heated against monarchy, the excellences and the virtues of the monarch were additional sources of irritation to him, in so far as they afforded pleas for the maintenance of the institution which he wished to destroy. They could not presume to say that such sentiments lurked in the bosom of a Dilke; but if they did, he had been successful in showing how the foundations of Royalty stood on a basis more solid than he had conceived, and how it was estimated by the whole body of the people. If ever the Queen was indebted to one of her subjects for showing how the

"Burden of state
And diadem's weight"

could be made light by a people's love, it was so in the case of the gentleman to whom he had referred.

The toast was duly honoured.

The next was "His Royal Highness the Prince of Wales, Vice-Patron of the Society, the Princess of Wales and the rest of the Royal Family."

The CHAIRMAN, in giving the toast, said recent events had proved that the Prince of Wales enjoyed the love and confidence of the free people of these realms.

The toast was duly honoured.

The CHAIRMAN said it now became his duty to ask them to drink the health of the distinguished nobleman, Her Majesty's representative in Ireland, and the President of that Society, who had honoured them with his presence there that evening. In proposing His Excellency's health, he felt that they were proposing the health not of a stranger, but of a friend. Associated as he had been with the government of Ireland now for some three years, His Excellency had never lost an opportunity of doing everything that in him lay to forward every work in which that Society was concerned, and he might say every work in which the interests of Ireland were concerned. It was, perhaps, true that His Excellency did not agree in opinion with everybody there; and with reference to that remark, he heard a very sensible explanation given by the late Archbishop of Dublin, at a dinner given by one of the predecessors of his right hon. friend, the Lord Mayor, who sat beside him. "I am very sorry," said the Archbishop, "that I find myself unable to agree with you all; but the reason of that, I may tell you, is a very simple one, and that is, that you do not all agree with each other.' In public affairs what they had to look to was, whether those who filled the highest offices in the State discharged their duties with perfect impartiality and had the interests of Ireland at heart; and if he was tried by that criterion, His Excellency was entitled to the most cordial reception that they could give him. Associated with the name of His Excellency was the toast of "Prosperity to Ireland." It was the duty of a great Society like that to keep fully informed all who were concerned in agriculture with the progress of agricultural industry in Ireland. They should not fancy that any year stereotyped and fixed the amount of advancement that agriculture could receive from the hands of science. Every year brought forward new improvements in science, in chemistry—in all those branches which tended to add to the expansion of the national resources; and it was one object in holding these shows to place the agricultural interest of Ireland in connexion with those great improvements, to get rid of the old traditionary farming, which men were but too often inclined to keep to, and to make themselves the pioneers in agricultural improvement. On the occasion of the present show the blue ribbon had been wrested from the breeders of short-horns, and had been won by a Devon, and had gone to an exhibitor from the north of Ireland. In different years it had been won successively by Kerry, Tipperary, Wexford, and Meath: this year it had gone to Monaghan. He rejoiced that the enterprising owner of the magnificent animal which had taken

the prize had reaped the reward to which he was so justly entitled. After briefly referring to the improvements which had been effected by the Society in farm implements, and pointing out that the Royal Dublin Society had been the parent of all the agricultural societies which now overspread the land, the Chairman concluded by proposing the toast.

His Excellency the Lord Lieutenant, on rising to respond, was received with warm applause. He said: Mr. Vice-President, my Lords and Gentlemen, I thank you very sincerely for the cordial manner in which you have received this toast. It is always gratifying to have fresh proof of that which we knew before, and I receive with great pleasure this fresh proof of the loyalty to the throne which distinguishes this Society. I thank you as representative of the Queen; and I thank you for the kind manner in which you have received me here to-day, and for the cheers with which you greeted me. But, gentlemen, I confess that although I have now had some experience of your kindness and consideration, it makes me the more diffident in rising to touch on a subject on which, before now, I have had to speak to you. I feel that nothing that I have to say is new on this subject, however important it may be to your Society, and to Ireland. It is gratifying to me to be able to repeat what I have thought it my duty to say to you before—namely, my congratulations on the success of this Spring meeting of the Royal Dublin Society. It is, I believe, the most important Exhibition which your Society holds in Dublin, for it is connected with the breeding of stock in this country. I believe I can congratulate you on the success of your meeting. The throng of people that we saw in your Court-yard and Show-yard to-day testifies the interest which all classes, and both sexes, feel in your Exhibitions. I do not ever remember having seen more people visiting your Show, and more interest shown in the proceedings of your Society. I believe that the stock exhibited is as good as it has been on former occasions. I know that one class, or rather two classes, representing the young stock—the young bulls—attained the large number of 172. That, I think, is a sign of the importance of these classes; and I believe that these animals, with their excellent qualities, will, after this Show, be spread all over the country, and be the means of improving the breed of animals in its different counties. The other classes, though not as numerous, exhibited very great signs of excellence, and show the various breeds that may with success be introduced into Ireland. But, as your Chairman told you to-night, this Society at its Spring Show does not confine its efforts to live stock, but has other branches of industry connected with agriculture which it encourages here. It encourages exhibitors of all sorts to come here with implements of tillage and articles connected with the household and the garden. Ploughs, harrows, reaping machines, washing machines, and articles of every conceivable description used on farms were exhibited in your yard to-day. All the results that have been attained in different countries by the riches of England, and the ingenuity of America, have been brought together here, and made available for every Irishman with a little money in his pocket, that chooses to come here and see your Exhibitions. I really do not know what might not be found in your yard. There was one very remarkable instance of the economy of labour which I witnessed, and by which, if I understood it rightly, a laundress could wash dirty linen, and from the same vessel draw forth limpid water, pure as from the fountains of Olympus. I commend that valuable article to the washerwomen of this city, and I can only condole with those excellent persons that soap suds cannot be converted into something stronger than pure water. I will pass on to other matters. I believe that the success of your Show with respect to those animals is only a reflection of the prosperity of the cattle trade in Ireland. It is very satisfactory to me to be able to state that hardly at any time was the trade in cattle in this country more prosperous than it is now. I do not wish to go into the field of statistics, for I know that figures are not palatable to any audience, and I am sure that they are very difficult for any speaker to handle with any chance of success. But when I say that the cattle trade of this country is in a satisfac-

tory state, I think I must adduce one or two figures to prove what I say. Now I looked to see how far the number of cattle in this country at the last return compared with the returns of former years, and I found that, with the exception of sheep, it was most satisfactory. I saw that, though sheep had decreased between 1870 and 1871 by the considerable number of 108,000 odd, cattle had increased by 173,000 and swine had increased by 155,500. That relates to the number of cattle in Ireland; but I also found—and this, perhaps is the most important point of the two—that the export trade of this country had in the same period largely increased. I found that there was an increase of 29,900 odd in the cattle exported from Ireland to England; that there was an increase also in the export of sheep of 63,874, and the large increase of 106,168 in swine. Now, I think that is very satisfactory. It shows that there is great confidence in England in the Irish market, and I think it is a satisfactory sign also that the health of the cattle in this country is good. That is a most important point. Fault has sometimes been found with the Government by the farmers of England with respect to the restrictions on the removal of diseased animals; but I think they must not too hastily say that those restrictions have done any harm to the trade of Ireland, for, as I have shown, the number of cattle in Ireland had considerably increased. and the export trade has also increased, at a time when those restrictions have been most rigidly enforced. Turning to England, I find that in all these matters there has been a decrease. There was a decrease in 1871, as compared with 1870, of 65,558 cattle, and of over a million in sheep. The only increase was in swine, of which animals there was a very large increase. Now, I do not at all know why this has taken place in England; but it is a fact which ought to be borne in mind, and which has something to do with the increase in the price of meat, of which so much has been lately made in the newspapers. I have very little doubt that the general prosperity of the community, and particularly of the working classes in Great Britain and Ireland, has very largely increased the consumption of meat; and the consequence of that naturally is, that the price of meat should have risen; but I believe the figures I have given in some degree account for it, and show that the rise in price is not to be entirely attributed to restrictions that have been imposed for the benefit of all the parties concerned. I hope these figures are satisfactory to you. I think they show how important this trade is to the people of Ireland. I hope, therefore, that our farmers will tend their cattle with care, and look after their health. Nothing is more important than that, not only with a view to securing a good market in other countries, but also as it affects the propagation of the stock; for, if you have disease amongst your cattle you may be quite sure that all sorts of accidents will occur, and that the increase in the number of the cattle will not be nearly so great as in other times. I, therefore, draw your attention to it in the hope that the greatest attention will be paid in Ireland to the health and care of the cattle. Now, it has often been said that this Society, and those who encourage the improvement of the breed of cattle only encourage one class of farmers in this country. They say that we are only encouraging the large farmers of the country, whereas we all know there is a very large and important class in this country who are very small farmers, and need such encouragement perhaps more than any other portion of our agricultural population. It is a very remarkable fact, particularly for Englishmen who are accustomed to the large farms of the midland counties, to see that out of the total of 608,864 agricultural holdings in Ireland, 317,457, or more than one half of the whole number of Irish farmers, are valued according to the valuation of 1866, at under £8 a year. I only mention this to show how very important and numerous that class of farmers is. I have heard that this Society is supposed not to give any encouragement to that class. I distinctly deny that. I admit that the small farmer, who has only perhaps four or five cattle, is not able to come up here at considerable expense to the Show, but I do not admit that he does not derive benefit from the exertions of the Society. Every good animal that

goes down from this Society to the country improves the breed of the animals around it, and it improves the breed of the cattle of the farmers, while it encourages the large farmers to bring such cattle up here. I therefore believe this Society encourages indirectly these men; and I deny also that those who encourage the increase of cattle in this country are encouraging the illegitimate conversion—I use the expression advisedly—of the tillage land into grass. Scotch farming shows that increased cereal crops also require a large increase of stock, and therefore I say the Society has improved tillage farming just as much as it has the grass farming by encouraging and developing the breed of cattle. I may now be allowed to refer to a matter rather personal to myself. I have always taken deep interest in this large class of small tillage farmers, and I have wished to prove my interest by doing something to improve their condition. Everybody will admit that the small farmers of this country are in a very backward state as to the cultivation of their farms. I know that in some parts of the country a great deal of good has been done, where small farms were in existence, by giving prizes to these small farmers; and I wish to show my interest in this class by offering some prizes. It was not a very easy matter to do, but I have, through the assistance of the National Board of Education, begun a scheme for this purpose, small, indeed in its immediate effect, but admitting, I trust, if successfully carried out, of very considerable extension and imitation in other districts. I have offered in each province of Ireland a certain number of prizes to be competed for in certain districts; and the districts I have chosen are the districts of certain school farms which have been established under the National Board. At Glasnevin we have seen what could be done on a very small farm. There are, as you know, different systems of farming employed there. One of them is the five acre farm, and the results of the farming on that farm are very remarkable. I believe I am correct in saying that, after making a calculation, and deducting for labour and so on, the net profit of that five acre farm has averaged from £50 to £60 a year. Now, I only mention that as an extreme case; it is perhaps the best model that could be attained; but is it not a practical illustration of what an independent Irish farmer, relying on his own resources, is able to do? I have, therefore, given prizes on certain conditions for the best small tillage holdings in an area of six miles around eight such districts. The Commissioners of National Education have kindly placed at my disposal the service of their Agricultural Inspectors for the adjudication of the prizes, and I am not without hope that indirect as well as direct advantage may result from the competition, and that we may obtain some valuable information as to the wants and position of the most important class of Irish agriculturists. I wish not to be laying down any rule whatever as to that most difficult subject—namely, the question of the relative size of farms. I should not presume to do that; I feel sure that so great a field is open for the improvement of small farmers in this country, that no solution of that question as to the right size of farms can be properly arrived at until a great improvement is made in the present condition of these small farms. I hope you will excuse me for having referred to this matter somewhat egotistically, yet I wished to offer some explanation of it, as in a few days from the present time a letter on the subject will appear. I feel I am only aiding, and that in a very small degree, the large efforts your Society has made to promote agriculture in Ireland. I thank you for the kind manner in which you have received my name, and allow me to conclude with my earnest wishes that the efforts of your Society may be long continued, with the success which has hitherto attended them.

The Chairman said the next toast on his list was one which it gave him great pleasure to propose—"The Health of the Lord Mayor of Dublin," who sat upon his left. For many reasons he felt happy in giving that toast, but chiefly because the Lord Mayor was the constant friend of that Society. In the course of his speech the Chairman paid a high tribute to the Lord Mayor for the manner in which he discharged his official duties on all occasions.

The LORD MAYOR, in responding, said that for many years he had felt a deep interest in the agriculture of Ireland. He was happy to congratulate that Society on the fact that their Shows were every year tending to promote the agricultural prosperity of Ireland. At no period did he remember the agricultural prosperity of Ireland to be better than at present. Rents were promptly paid, and that class to which His Excellency had alluded—the small farmers—were also in a prosperous and rising state. Having alluded to the Corporation of Dublin, and the zealous and faithful manner in which its members discharged their duty, he concluded by thanking them for the kind manner in which they had received the toast of his health.

HIS EXCELLENCY the LORD LIEUTENANT next proposed "the Health of the Vice-President, Mr. George Woods Maunsell," and, in doing so, congratulated the Society on its connexion with that gentleman, who rendered such useful service to the body.

Mr. MAUNSELL briefly returned thanks.

Viscount POWERSCOURT proposed the next toast—"The Royal Agricultural and Royal Horticultural Societies."

Lord VENTRY responded. Both Societies, he remarked, were twin sisters; for whatever advanced the interests of the one also served the other. He spoke of the services rendered throughout Ireland by the Shows of the Royal Agricultural Society, and maintained that the operations of that body and the Royal Horticultural Society had proved most beneficial to the country.

Mr. ALEXANDER PARKER proposed the toast of "The Press," to which Alderman Purdon ably responded.

Mr. ROBERT C. WADE gave "The Health of the Judges."

Mr. JACOB WILSON, of Woodborn Manor, Morpeth, responded on behalf of his brother Judges and himself. He congratulated the Society on having succeeded in bringing together so fine a collection of young Bulls, which afterwards would be scattered through the length and breadth of Ireland, and thus improve the stock whereon they might be placed. Largely and immediately as Ireland was interested in this matter, he observed that England would be equally benefited with Ireland, whether so large an importation of Irish Cattle takes place; for, whatever was a benefit to the Irish *breeder* was equally so to the English and Scotch *feeder*. He also observed that if any means could be adopted by which cattle could be more *comfortably* transported from Ireland to Great Britain, it would be a great boon to both countries, as removing a very exciting cause of disease.

Mr. J. L. NAPER, in proposing the toast of "The Health of the Successful Competitors," expressed his satisfaction that the Cup on the present occasion was won, not by a professional exhibitor, but by a tenant farmer.

Mr. ARCHDALL returned thanks.

The company then separated.

The correspondence alluded to by His Excellency in the above speech was as follows:—

"VICEREGAL LODGE, DUBLIN,
"29*th March*, 1872.

"GENTLEMEN—By His Excellency's desire, I am to request that you will lay before the Commissioners of National Education the following proposition in his behalf, in the hope that they may be able to assist him in the manner suggested.

"I am to state that His Excellency has long taken an especial interest in the welfare of the very numerous class of Irish small tillage farmers, and has held the opinion, which personal observation of their condition and prospects in various parts of the country has amply confirmed, that their present style of farming, and the management of their homesteads, admit of considerable improvement. It appears that more than half of all the holdings in Ireland—

namely, 317,457 out of 608,864 (from both of which figures, however, some deductions must be made for the cases in which two or more separate holdings, being in the occupation of the same individual, are enumerated separatetly) were valued in 1866 at less than £8 a-year. His Excellency thinks it will not be disputed that, in a vast majority of cases, these holdings are imperfectly cultivated, and that the habitations on them are, speaking generally, both inferior and ill-kept. Under these circumstances, and considering that the settlement of the land question under the Act of 1870 has turned the attention of the public to the general condition of the farming classes, and has given sa impetus to many improvements in the management of farms, the present has seemed to His Excellency a favourable occasion for an endeavour to direct attention to this very large and important class of agriculturists. In doing so, I am to state that he does not desire to raise or to pronounce any opinion upon the very difficult question of the proper size of farms. He would carefully avoid that; but, at the same, he is confident that that most interesting question cannot be satisfactorily solved in this country until the small farmers of Ireland avail themselves of the means at their disposal for careful tillage much more extensively than they do now. Among the methods empl oyed to promote good agriculture, His Excellency is of opinion that nothing has been more calculated to benefit the small farmers than the school farms or gardens under the inspection of the National Board of Education, which he is glad to observe are gradually increasing in number. Accordingly, it has occurred to him, more in the hope of seeing his action—if successfully carried out—imitated by others, than from any notion that so small a contribution can have any very considerable effect in itself, to offer, on certain conditions, Prizes to be adjudged in connexion with certain of these school-farms. He has selected eight of them in various parts of the country, viz.:—

"In Leinster—GARRYHILL and BALLINAVALLY,
"In Ulster—CARNAGILTA and PARKANOUR,
"In Munster—TERVOE and GRANGE,
"In Connaught—CASTLEHACKET and KILLESHANDRA,

and, taking round each of them a radious of five or six miles, he proposes to give annually for the next five years, three prizes to be called the 'Spencer Small Farm Prize, and consisting of £3, £2, and £1 respectively, to the occupiers of the three holdings in each of the areas above described, and valued under £8 a year, which shall be adjudged to be the most commendable on the score of

(I). "The neatness and cleanliness of the house;
(II). "The amount and quality of the produce of the land;
(III.) "The character and condition of the live stock of all sorts, from cows and horses down to poultry and bees;
(IV). "Any other circumstances that may attract the favourable attention of the judges.

"These prizes should be adjudged about the month of September, in each year. In no case should the same individual obtain a prize more than three times in the five years, nor should any prize be given unless there be both competition and merit, as to the requisite extent of which the judges should decide.

"I am to state that His Excellency's object in addressing the Commissioners on this subject is to solicit the co-operation of the Board to the extent of allowing their agricultural school inspectors, than whom assuredly none could be better qualified—both by their special acquaintance with the subject, and by the confidence that would be generally felt in the fairness of their awards—to adjudge these prizes, commencing from September next.

"If his proposal is adopted by the Board, His Excellency believes, that in addition to any direct benefits that may accrue from increased exertion on the

part of individuals, it is possible that indirectly a good deal of valuable information may be obtained as to the wants and position of a very large and important class, and that it may be found desirable to have a short yearly report by the inspectors, conveying their impressions on the subject.

"I have the honour to be, Gentlemen,
"Your obedient Servant,
"H. Y. THOMPSON.

"*The Secretaries of the Board of Education.*"

"OFFICE OF NATIONAL EDUCATION,
Dublin, *April* 9, 1872.

"SIR,—We have to inform you that the Commissioners of National Education have had before them this day your letter of the 29th ultimo, which conveys a proposal of His Excellency the Lord Lieutenant, to establish a scheme of prizes for the best managed farms, situated within a radius of five or six miles of certain Agricultural Schools in each of the four Provinces, and inviting the Board to place at His Excellency's disposal the services of the Agricultural Inspectors to adjudge the prizes.

"We are directed by the Commissioners to inform you that they feel much satisfaction in complying with His Excellency's request.

"We are, Sir,
"Your obedient Servants,
(Signed) "JAMES KELLY.
"W. H. NEWELL.

"*H. Y. Thompson, Esq.*"

EVENING SCIENTIFIC MEETINGS.

MONDAY EVENING, NOV. 29, 1871.

ROBERT STAWELL BALL, A. M., Professor of Applied Mathematics and Mechanism, in the Chair.

The CHAIRMAN observed that the experiment of holding discourses on three evenings in the last Session, to which ladies were admitted, had proved so successful that it would be repeated during this Session also. The Royal Dublin Society was well known for identifying itself with the practical Arts, Sciences, and Manufactures of Ireland; and there were two subjects on which he should be particularly glad to find communications brought forward. One was the utilisation of peat. Much energy and capital had been fruitlessly expended in this attempt; but the cause of failure was rather to be sought in the wrong direction of the trials than in the impracticability of utilising the peat. This was the opinion of Sir William Fairbairn in his treatise on iron, and of other competent authorities. Ireland produced abundant peat and iron, and peat fuel produces iron of remarkably good quality. It would be a cause of regret if the question of the utilisation of peat should be allowed to drop. Again, the Chairman thought that the long indented coast of Ireland was particularly well suited for the cultivation of oysters, and a Special Commission had already published a valuable Report, strongly advocating the artificial propagation of oysters all round the Irish coast.

Mr. MAURICE COLE, of Stranraer, N. B., made a verbal communication respecting an "Improved Method of Sowing all Agricultural Seeds from one Common Centre," illustrated by a model of the instrument. The model exhi-

bited consisted of a long wooden box having a longitudinal opening of about three inches wide in its bottom, which was closed by a wooden cylinder, to the projecting ends of which were affixed the two wheels of the implement. Small holes were counter-sunk at intervals in the cylinder. Grain being put into the box, and the implement being drawn along the ground, the cylinder was caused to revolve, and in doing so a grain or two was delivered at the moment each depression in the cylinder was brought to the edge of the longitudinal opening. The model worked perfectly satisfactory when shown in the room, but subsequently when tried in the field it was by no means successful.

Mr. Cole at the same time exhibited a Buoy for receiving the papers and valuables of a ship when about to founder, and described others of his inventions.

Professor Edward Hull, F. R. S., Director of the Geological Survey of Ireland, made a communication describing a recent visit to Vesuvius. Views of Naples, with Vesuvius in a quiescent and active state, were exhibited on the screen.

Dr. J. Emerson Reynolds exhibited a new apparatus for Gas Analysis. The gas to be examined is first placed in a tube under mercury. The upper part of the tube is connected with a long column, and the lower to another column, the latter reaching up, and open to the air. The gas is then transferred to the measuring tube, to ascertain its volume. On being returned to the tube, carbonic acid (for instance) was first eliminated by caustic potash; the gas retransferred and measured, the difference giving the quantity of carbonic acid. The same process is repeated with other reagents for other gases, till the composition of the gas to be examined was ascertained. By this means gases can be analysed in a very short time, which would require three or four days by other methods, and with equal accuracy.

Mr. A. G. More, Assistant in the Natural History Museum, exhibited a fine specimen of the Ruddy Shieldrake or Braminy Duck, *Casarca rutila*, recently shot on Clonea Marsh, about four miles from Dungarvan, and presented to the Museum by Mr. W. W. M'Guire, of Clonea House; a great Indian Hornbill, *Buceros cavatus;* and an immature Indian Lammergeger, *Gypaetos barbatus*, presented by Mr. B. Blood; and some living specimens of the rare slug *Geomalacus maculosus* from Lough Caragh. were also exhibited.

Monday Evening, December 18, 1872.

Howard Grubb, C. E., Vice-Chairman of the Science Committee, in the Chair.

Professor R. S. Ball, read a discourse "On the Conservation of Energy."

Monday Evening, February 19, 1872.

Professor Ball, LL. D., in the Chair.

Dr. J. Emerson Reynolds, Keeper of the Minerals and Analyst, delivered a discourse "On Coal Gas and its Flame."

Monday Evening, March 18, 1872.

Professor Ball, LL. D., in the Chair.

Mr. John B. Wigham read a Paper "On Gas for Lighthouse Illumination."

Mr. W. F. Kirby, Assistant in the Museum of Natural History, read a Paper "On the Species of Saturnidæ or Pullatra Silk-worm Moths in the collection of the Royal Dublin Society."

MONDAY EVENING, APRIL 15, 1872.

Professor BALL, LL. D., in the Chair.

GEORGE JOHNSTONE STONEY, A. M., LL. D., Secretary of the Society, delivered a discourse "On the Magnetism of the Earth."

MONDAY EVENING, JUNE 3, 1872.

Professor BALL, LL. D., in the Chair.

DR. JAMES M. BARRY read a Paper "On Cotton Growing in Fiji, with some Remarks on the Country and its Inhabitants."

At its conclusion, the Lecturer called attention to a specimen of the Orange Cowry, which was on the table. This shell is peculiar to the Fiji Islands, and is the perquisite of the King, who wears it round his neck, or carries it on a stick as a sceptre. It was consequently very difficult to procure, a specimen being valued at £5; every example obtained had a hole drilled in it for a string to be passed through.

Mr. JOHN ADAIR said that his son had just returned from the South Seas. He and another midshipman once started to walk across one of the Fiji Islands (about twelve miles), to visit a king on the opposite coast. They reached the palace in safety, and passed the night there. They were entertained with dances and amusements, and received the greatest hospitality from the king, being treated in a semi-civilised fashion. Mr. Adair's son brought back a few shells with him, and would have brought more, but some were thrown overboard by the sailors. A friend of his had an Orange Cowry which had not been pierced.

Dr. STEWART called attention to the commercial view of the subject. The object of the Paper seemed to be to bring before Irish speculators the advantages of Fiji for cotton-growing, but at present there was too much uncertainty for life and property. Nevertheless great advance has been made in one of the most fearfully savage districts in the world, for which mankind is chiefly indebted to the Wesleyan Missionaries. Civilisation has commenced on the seashore, and is gradually spreading up the country.

Mr. HULL said that it was only due to Dr. Barry to say that his account seemed very fair and accurate. If young men went out to Fiji with a small capital, they would, with energy and perseverance, be very well repaid. He believed that land was still to be had for less than a pound an acre.

Dr. BARRY remarked that Dr. Clarkson sent several bales of Fiji cotton to London last year, which realised a very good price.

Mr. HULL then read a Paper on the newly-discovered Hæmatite of Cavan.

Dr. BARRY remarked on the importance of the subject in view of the present great increase in the value of iron. There was great difficulty in smelting iron in Ireland. The vast iron resources of Ireland are not developed as they should be. The quality of iron smelted with peat is very superior. Formerly the Earl of Cork derived £100,000 a year from the Irish iron trade; but after the forests were destroyed, Irish iron could no longer compete with Welsh. The sun-fish fishery was of importance in the west of Ireland. English harpoons were unequal to the work, and were hardened by means of peat before they were used. Nothing was required to develop the iron-trade in Ireland but improved machinery, capital, and energy.

The CHAIRMAN inquired if it was proposed to smelt the iron with peat at the Arigna mines, or with coal if it were found in the neighbourhood. Judge Fairbairn said that if peat was used, the mines would become the most valuable in Ireland.

Mr. HULL said that coal was found in the Arigna district. The original company used this coal, and the new company propose to use the same, and to smelt their iron on the spot. Iron smelted with wood was the purest, but very excellent iron might be produced with peat. It was necessary for success at the present day that everything should be done on a very small scale. It was to be feared that if peat was used, it would break down in the furnaces, and prove not to be workable. If this objection could be got over, peat could not be put to a better use.

Major W. H. COLLINS, R. E., read a Paper "On a New Angle Measure for Observations in the Field," which created much interest.

Dr. STEELE, in the absence of the author, read a Paper by Dr. J. EMERSON REYNOLDS, Professor of Analytical Chemistry, and Keeper of the Minerals, "On the Chemical Action of Light."

The following Letter from Professor Reynolds was recently read to the Council:—

ROYAL DUBLIN SOCIETY, KILDARE-STREET,
August 22nd, 1872.

MY LORDS AND GENTLEMEN,—The utilization of Peat has so often occupied your attention, since the publication of Sir Richard Griffith's and other engineers' valuable reports on the Bogs of Ireland, and public interest in the subject is now so fully aroused, that I venture to bring under your notice a mode of employing Peat as fuel for industrial purposes, which appears to have been either overlooked or strangely neglected in this country. The successful and economical use of Peat in manufactures is, in my opinion, more likely to depend on the proper adjustment of the furnace to the fuel than of the fuel to the furnace, the costly preparation of Peat being open to many serious objections. In 1862, the venerable Professor Faraday delivered his last lecture at the Royal Institution of Great Britain, and took for his subject "Siemens' Regenerative Gas Furnace." At the time, I was much impressed with the admirable apparatus described, in consequence of the facilities it afforded for the combustion of any such bulky fuel as Peat, and have since watched with great interest the gradual improvements effected through the costly and laborious experiments of Mr. Siemens. Some estimate of the extent of these investigations may be formed when it is stated that, up to the year 1862, the inventor held two patents for regenerative gas furnaces; but he has since secured eighteen patents for improvements in his apparatus, and applications to various kinds of manufactures, including the production of cast steel direct from the ore, of zinc, glass, pottery, &c. I may now briefly describe the apparatus in general terms.

In the regenerative gas furnace the fuel is very simply converted into combustible gas, in a large separate chamber of peculiar construction; the gases then conducted into the furnace containing the material to be heated, and there burnt with hot air. After use, the intensely heated products of combustion are made to pass through brick chambers called "regenerators," and the heat which would otherwise be wasted is caught, stored up in the bricks, and subsequently made to raise to a very high temperature the air, &c., required to supply the furnace.

It is unnecessary here to enter into details of construction; but I may be allowed to point out that, in addition to the economy of heat resulting from the use of this apparatus, two special and most important advantages are gained. In the first place, a bulky fuel like Peat, containing a large proportion of worthless and often injurious ash, can now be easily and successfully employed in several important manufactures, since it is no longer necessary to bring the solid fuel into direct contact with the material to be heated. Secondly, the use of a very dry fuel is not required, owing to a peculiarity in the mode of working the fur-

naces. Considerations of this kind clearly lead to the conclusion that Siemens' apparatus is specially suitable for the combustion of rough and simply air-dried Peat. I have now the pleasure to submit a letter lately received from Mr. C. W. Siemens, D. C. L., F. R. S., upon this subject. When it is stated that Mr. Siemens has not only constructed furnaces on his principle in Great Britain and on the Continent, but he has also erected works of his own at Birmingham, in order to perfect the details of his plan on a larger scale, and adapt the apparatus to different kinds of fuel, the value of his opinion can be easily appreciated.

"3, Palace Houses, Kensington Gardens, W.
August 16*th*, 1872.

"Dear Sir,—In reply to your letter, I have much pleasure to state that you are perfectly right in your opinion that Peat simply air-dried is very suitable fuel for my regenerative gas furnace. I have used it abroad for working glass furnaces, and I have employed it with complete success for making steel in this country. Indeed the men gave the preference to Peat over Staffordshire Coal in working the furnaces.

"In England Coal is, of course, the cheaper fuel; but I am convinced that through the application of Peat as you suggest, several branches of industry may be planted with great advantage in Ireland.

"Regarding the heating value of Peat as compared with Coal, it can be arrived at for my purpose by simply ascertaining the relative percentage of solid carbon in both. The water (if not in excess) may be regarded merely as a deduction, without injury to the heating value of the solid constituents, as would be the case in burning the fuel direct. The vapour of water mixed with the gas is all condensed, in the cooling tubes of my apparatus, before reaching the furnace.

"If the Peat fields of Ireland should be made available for industrial purposes, you would accomplish a most desirable object, and I would be glad to give you every assistance.

"I remain, dear Sir,
"Yours faithfully,
"C. William Siemens.

"Professor Emerson Reynolds,
Royal Dublin Society."

The adjustment of apparatus to material, of furnace to fuel, has, therefore, been successfully made by Mr. Siemens; and I venture to hope that, through your influence, Irish manufacturers may be induced to utilize the power now evidently at their command.

I have only to add, in concluding this Report, that the specifications above referred to, and working plans of furnaces, &c., are to be found in your Patent Library.

I have the honour to be,
My Lords and Gentlemen,
Your obedient Servant,
(Signed) J. Emerson Reynolds.

The Council having referred the foregoing Letter to the Committee of Science for consideration, with authority to confer with manufacturers and other skilled persons on the subject, the following is the

REPORT.

By a Resolution of the Council of the Royal Dublin Society, bearing date the 22nd August, 1872, Professor Reynolds' Letter of the same date was referred to the Committee of Science for their consideration and Report, with power to avail themselves of the advice of any persons who could aid them in forming a correct estimate of the value of his proposal.

Accordingly your Committee have held three Meetings. At the first of these Meetings Sir Richard Griffith gave the Committee valuable information in reference to the extent, constitution, depth, and locality of the principal Bogs of Ireland, and of the cost of draining and working them. At that Meeting the Committee passed a Resolution requesting the following Engineers and other gentlemen to give them their assistance, viz.:—Mr. Baldwin, Mr. John Bailey, C. E.; Mr. C. P. Cotton, C. E.; Mr. Alexander M'Donnell, C. E.; Mr. James Price, C. E.; Mr. George A. Stephens, and Mr. B. B. Stoney, C. E.

Every one of the persons so invited attended the next Meeting of the Committee, and placed at the disposal of the Committee the information and advice which their great experience and skill enabled them to give. Without this generous response to the invitation, it would have been difficult for the Committee to have made a Report on this subject as full as is desirable; and they therefore beg to suggest that the marked thanks of the Council are justly due to each of those gentlemen.

Professor Reynolds' proposition is, that Peat should be employed as fuel for manufacturing purposes in Ireland in Gas Furnaces, constructed on Siemens' regenerative principle. The advantages anticipated from its use in this particular kind of furnace are—

1st. That the Peat need not be specially prepared, but can be used in the form of the familiar air-dried sods.

2nd. That the presence of the water, which remains in such Peat, is not prejudicial; and—

3rd. That the bulk of the fuel, and the quantity of ash, do not interfere with the concentration of heat in the furnace.

Siemens' Furnace consists of a gas-producing apparatus, and the furnace proper. The fuel is partially burned into combustible gas in a chamber, which is distinct from the furnace in which the resulting gas is to be used, and may be at any distance from it. This peculiarity renders it possible to employ with advantage a great variety of inferior fuels in Siemens' furnaces, as water can be removed from the gaseous products by condensation.

The evidence given to the Committee, and the result of their own inquiries, have led them to arrive at the following conclusions, viz.:—

1st. That Siemens' Regenerative Gas Furnace is eminently adapted to a very large number of manufacturing purposes; in fact, to most in which a very high temperature is required, and in which the work to be done permits the furnace to be entirely closed. It was given in evidence that it has been successfully applied to the production of Iron and Steel direct from the ore, to Glass Works, Pottery, Zinc Works, forging on the largest scale, and many branches of manufacture.

2nd. That rough air-dried Peat, containing on the average 25 per cent. of water, is suitable fuel for a Siemens' furnace.

3rd. That Peat, when burned in this furnace, compares more favourably with Coal, as regards heating power, than when used in any other known way. It has been stated to the Committee that with ordinary appliances, the general heating power of $2\frac{1}{4}$ tons of average Peat is about equivalent in practice to one ton of average Coal. On the other hand, the proportion in Siemens' Furnace appears to be much more in favour of Peat, and to assign a value to Peat not less than 65 per cent. of the value of Staffordshire Coal. The Committee have

not been able to ascertain the heating value of Coal refuse, which is also a fuel employed in Siemens' Furnaces, so that the Committee are unable to state the proportion of value between Peat and such fuel. The Committee has been informed by Mr. Siemens that Peat mixed with about 25 per cent. of Coal-dust (by preference Newcastle Coal-dust) gives a richer gas than Peat alone.

The extent of bog which is available appears to be immense, and the bogs are so distributed over Ireland that they must in many cases be in the immediate neighbourhood of the places where manufactures may be expected to arise. In such cases the gas-producing apparatus might be situated at the bog, and the gas conveyed to the factory by culverts. The facilities of transport by Rail and Canal are likewise very considerable. It was stated to the Committee that the Midland Great Western Railway Company alone have lines running through seventy miles of bog; and it is well known that the Royal and Grand Canals pass through the Bog of Allen, the most extensive in Ireland.

The Committee are informed that the present price of the lowest class of Coal in the Liffey, for manufacturing purposes, is about twenty-nine shillings a ton, and that Peat is at present delivered into the Canal Boats at the bog at about seven shillings per ton. This corresponds to a price of about twelve shillings in large quantities in Dublin. To this must be added any increase of price which will result if the rent of bogs be raised. On the other hand, the Committee are led to believe that the cost of cutting and saving Turf may be greatly reduced by the application of machinery. A deduction must also be made from the value of Peat, in consequence of the great storage room which it requires, and which is estimated at 5⅝, or nearly six times the space required for the same weight of Coal.

It will be collected from what has been already stated, that the Committee have been led to attach much importance to Professor Reynolds' suggestion; and they have great satisfaction in reporting that two Siemens' regenerative gas furnaces are in process of construction, with a view to the employment of Peat at the works of the Great Southern and Western Railway at Inchicore, under the direction of the Chief Engineer, Mr. Alexander Mac Donnell, and that they will probably be in operation before the close of the present year, and will afford an opportunity of more fully testing the value of this mode of using the chief fuel of Ireland.

(Signed) ROBERT STAWELL BALL, LL. D.,
Chairman.

September 18, 1872.

APPENDIX.

METEOROLOGICAL JOURNAL,

KEPT AT

The Royal Dublin Society's Botanic Garden, Glasnebin,

[HEIGHT ABOVE LEVEL OF SEA, 65 FEET,]

FROM

1st JUNE, 1871, to 28th SEPTEMBER, 1872

JUNE, 1871.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Cor-rected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Thursday, . . .	30·176	67	30·075	67	54	51	59	60	68	64	N. E.	7	. .	Fine, breezy, bright sunshine.
2 Friday, ...	30·250	57	30·176	59	42	39	57	59	61	58	N. E.	4	. .	Breezy, cloudy, occasional sun.
3 Saturday, . . .	30·300	55	30·232	55	41	38	54	57	57	54	N. W.	0	. .	Cloudy, mild, changeable.
4 Sunday, . . .	30·100	54	30·032	55	50	46	52	55	57	54	N. W.	0	·060	Cloudy, mild, showery day.
5 Monday, . . .	30·280	60	30·185	61	45	42	54	56	63	58	N. W.	0	·040	Do.
6 Tuesday, . . .	30·234	64	30·149	66	51	48	55	57	67	63	N. W.	4	. .	Fine, breezy, occasional sunshine.
7 Wednesday, . .	30·140	64	30·045	65	52	50	55	57	67	63	S. W.	4	. .	Do.
8 Thursday, . . .	30·084	60	29·999	61	47	44	55	57	62	58	N. W.	0	. .	Breezy, cloudy, changeable.
9 Friday, ...	30·020	59	29·941	59	51	49	55	57	60	57	N. E.	2	. .	Fine, mild, occasional sunshine.
10 Saturday, . . .	29·944	61	29·861	61	39	37	56	58	62	59	S. E.	4	. .	Breezy, changeable, occasional sun.
11 Sunday, . . .	29·840	59	29·762	59	50	47	56	58	61	58	S. E.	0	. .	Breezy, cloudy, changeable day.
12 Monday, . . .	29·978	62	29·890	62	49	47	57	58	63	59	S. E.	2	. .	Breezy, cloudy, occasional sunshine.
13 Tuesday, . . .	29·696	56	29·623	56	53	50	55	57	58	55	S. E.	0	·020	Strong, breezy, light showers.
14 Wednesday, . .	29·700	63	29·612	63	54	53	57	58	65	61	S. E.	2	. .	Breezy, cloudy, occasional sunshine.
15 Thursday, . . .	29·840	64	29·746	64	54	52	59	60	66	62	S. E.	5	. .	Fine, breezy, bright, sunshine day.
16 Friday, ...	29·750	66	29·651	66	51	49	58	59	67	63	S. E.	4	·010	Occasional sun, light showers, changeable.
17 Saturday, . . .	29·650	65	29·556	68	51	49	58	60	71	67	S. W.	4	. .	Breezy, changeable, occasional sun.
18 Sunday, . . .	29·440	59	29·363	59	51	49	56	58	59	56	S. W.	0	·090	Cloudy, mild, showery day.
19 Monday, . . .	29·480	62	29·393	62	51	49	57	58	63	59	S. W.	2	·230	Breezy, showery, occasional sunshine.
20 Tuesday, . . .	29·790	61	29·707	60	51	48	55	57	60	57	N. W.	2	·060	Do.
21 Wednesday, . .	29·892	63	29·804	64	47	46	55	57	65	61	S. W.	2	·370	Breezy, wet, occasional sunshine.
22 Thursday, . . .	29.832	56	29·759	57	57	56	55	57	59	56	S. E.	0	·040	Cloudy, changeable, light showers.
23 Friday, ...	30·030	50	29·972	50	49	48	52	55	51	48	N. E.	0	·350	Cloudy, wet, changeable day.
24 Saturday, . . .	30·224	58	30·145	59	41	40	52	54	61	57	N. W.	7	. .	Fine, breezy, bright sunshine.
25 Sunday, . . .	29·272	62	29·182	62	42	40	53	55	68	60	N. W.	5	. .	Breezy, changeable, occasional sunshine.
26 Monday, . . .	30·350	64	30·260	64	43	41	54	56	66	62	N. W.	8	·230	Breezy, heavy showers, bright sun.
27 Tuesday, . . .	29·960	60	29·877	61	53	50	55	57	63	60	S. E.	0	·180	Cloudy, showery, changeable day.
28 Wednesday, . .	29·690	60	29·607	61	55	53	55	57	63	60	S. W.	4	. .	Breezy, changeable, occasional sunshine.
29 Thursday, . . .	29·620	55	29·553	56	50	48	54	56	58	56	S. E.	0	·190	Breezy, wet, changeable day.
30 Friday, . . .	29·578	61	29·485	62	50	48	54	56	63	60	S. E.	5	·050	Breezy, showery, occasional sunshine.
												77	1·870	inches.

JULY, 1871.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Saturday, . .	29·680	63	29·602	64	50	49	56	58	66	62	S. E.	4	·020	Breezy, showery, occasional sunshine.
2 Sunday, . .	29·680	60	29·597	61	54	55	56	57	62	59	S. W.	2	·080	Breezy, showery, changeable, occasional sun.
3 Monday, . .	29·540	57	29·467	59	49	48	56	58	60	57	S. E.	0	·680	Breezy, heavy showery day.
4 Tuesday, . .	29·596	62	29·508	63	53	51	57	59	65	61	S. W.	3	·270	Cloudy, showery, occasional sunshine.
5 Wednesday, .	29·922	62	29·834	61	52	50	54	55	61	58	S. W.	2	·280	Do.
6 Thursday, . .	29·922	68	29·818	70	53	51	55	57	72	68	S. W.	5	·340	Breezy, showery, occasional sun.
7 Friday, . . .	29·780	64	29·686	64	53	51	57	59	65	62	S. W.	2	·100	Cloudy, showery, changeable, occasional sun.
8 Saturday, . .	29·650	64	29·556	65	51	49	56	58	67	64	S. W.	2	·080	Do.
9 Sunday, . . .	29·820	61	29·737	61	51	49	55	57	61	59	S. W.	2	·180	Showery, occasional sun, thunder, changeable.
10 Monday, . .	29·898	63	29·808	64	48	46	56	58	66	62	S. E.	5	. .	Breezy, bright sun, changeable.
11 Tuesday, . .	29·898	62	29·808	63	47	46	55	58	65	62	S. W.	5	·040	Breezy, bright sun, light showers.
12 Wednesday, .	29·720	59	29·642	60	52	49	56	58	62	59	S. W.	0	·050	Cloudy, showery, changeable.
13 Thursday, . .	29·560	64	29·466	66	57	55	57	59	68	64	S. E.	0	·140	Do.
14 Friday, . . .	29·772	71	29·663	72	55	53	59	60	73	69	S. W.	7	. .	Fine, breezy, bright sunshine day.
15 Saturday, . .	29·800	64	29·806	65	55	53	58	60	67	64	S. W.	0	·060	Breezy, showery, changeable.
16 Sunday, . . .	30·120	68	30·014	69	52	49	59	60	70	67	S. E.	7	. .	Fine, breezy, bright sunshine, day.
17 Monday, . .	30·028	65	29·953	66	60	58	69	62	69	66	S. W.	3	. .	Breezy, cloudy, occasional sunshine.
18 Tuesday, . .	30·094	65	29·999	67	49	47	59	61	68	65	S. W.	4	. .	Do.
19 Wednesday, .	29·680	63	29·592	65	50	49	59	61	66	63	S. W.	0	·300	Showery, cloudy, changeable.
20 Thursday, . .	30·020	64	29·925	65	49	47	57	60	66	63	S. W.	3	·050	Showery, occasional sunshine.
21 Friday, . . .	29·750	62	29·662	62	55	53	57	59	63	60	S. W.	0	·300	Breezy, cloudy, showery day.
22 Saturday, . .	29·540	63	29·452	63	53	51	57	59	64	60	S. W.	3	·080	Breezy, showery, occasional sunshine.
23 Sunday, . . .	29·639	62	29·542	62	53	51	57	59	64	61	S. W.	2	·290	Thundery, heavy showers, occasional sun.
24 Monday, . .	29·568	59	29·490	59	53	51	55	58	60	57	S. E.	0	·360	Cloudy, showery, changeable day.
25 Tuesday, . .	29·560	60	29·278	60	48	46	54	57	62	58	N. W.	4	·630	Breezy, heavy showers, occasional sun.
26 Wednesday, .	29·390	62	29·303	64	50	47	54	57	65	61	N. W.	5	·080	Breezy, light showers, occasional sun.
27 Thursday, . .	29·840	65	29·746	67	46	44	55	57	67	63	N. W.	7	. .	Fine, breezy, bright sunshine.
28 Friday, . . .	29·840	63	29·752	64	54	52	56	58	64	60	N. W.	4	·250	Breezy, showery, occasional sunshine.
29 Saturday, . .	29·650	62	29·562	62	50	47	56	58	62	59	S. E.	0	·270	Cloudy, heavy showers, changeable.
30 Sunday, . . .	29·632	56	29·559	57	45	43	54	56	56	54	N. E.	2	·220	Thundery, heavy showers, occasional sunshine.
31 Monday, . .	30·010	64	29·915	66	48	46	55	58	66	63	S. W.	7	. .	Fine, breezy, bright sunshine day.
												90	4·950	Inches.

AUGUST, 1871.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P.M.	Observed Height.	Therm.	Cor- rected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Tuesday, . . .	29·950	65	29·856	65	54	51	57	59	65	62	S. E.	0	. .	Breezy, cloudy, changeable day.
2 Wednesday, .	29·928	67	29·829	67	57	55	59	60	68	64	S. E.	2	. .	Cloudy, mild, occasional sunshine.
3 Thursday, . .	29·600	65	29·506	67	56	55	60	61	67	63	S. W.	3	. .	Breezy, changeable, occasional sunshine.
4 Friday, . . .	29·800	61	29·717	62	50	49	57	60	63	60	S. W.	4	·030	Breezy, light showers, occasional sunshine.
5 Saturday, . .	30·060	66	29·959	68	52	49	58	60	69	65	S. W.	3	. .	Breezy, changeable, occasional sunshine.
6 Sunday, . . .	30·240	69	30·134	69	57	55	60	62	70	66	S. E.	6	. .	Fine, breezy, bright sunshine.
7 Monday, . . .	30·100	67	29·999	67	55	53	61	63	68	67	S. E.	7	. .	Do.
8 Tuesday, . . .	30·070	71	29·849	71	54	52	62	64	72	67	N. E.	5	. .	Cloudy, mild, occasional sunshine.
9 Wednesday, .	30·150	72	30·033	72	55	53	63	64	73	67	N. E.	7	. .	Fine, warm, bright sunshine.
10 Thursday, . .	30·100	75	29·978	76	55	53	63	64	77	72	S. W.	7	. .	Do.
11 Friday, . . .	30·100	69	29·994	69	56	54	63	65	69	66	S. E.	0	. .	Cloudy, mild, changeable day.
12 Saturday, . .	30·100	70	29·989	70	58	56	64	64	71	68	S. E.	6	. .	Fine, breezy, bright sunshine.
13 Sunday, . . .	30·100	71	29·989	71	58	56	65	66	72	68	N. E.	6	. .	Fine, breezy, warm, bright sun.
14 Monday, . . .	30·050	62	29·960	62	51	49	61	63	63	60	N. E.	0	.	Cloudy, breezy, changeable.
15 Tuesday, . . .	30·060	68	29·954	69	50	49	61	63	69	66	N. E.	7	. .	Fine, breezy, bright sunshine.
16 Wednesday, . .	30·030	66	29·929	66	49	47	60	63	67	64	S. E.	3	. .	Cloudy, occasional sun, changeable.
17 Thursday, . .	29·772	60	29·689	60	54	51	59	61	60	58	S. E.	0	. .	Breezy, cloudy, rain-like day.
18 Friday, . . .	29·430	63	29·343	63	57	55	59	61	63	60	N. W.	0	·430	Breezy, heavy rain, changeable day.
19 Saturday, . . .	29·970	62	29·882	62	46	44	56	59	62	59	S. W.	4	·040	Cloudy, showery, occasional sunshine.
20 Sunday, . . .	29·650	61	29·567	63	57	55	58	60	64	60	S. W.	0	·620	Breezy, heavy rain, changeable.
21 Monday, . . .	30·100	62	30·010	62	52	50	58	60	63	68	N. E.	7	. .	Fine, breezy, bright sunshine day.
22 Tuesday, . . .	30·000	65	29·905	65	43	40	57	59	65	61	S. W.	4	. .	Breezy, cloudy, changeable, occasional sun.
23 Wednesday, .	29·816	65	29·722	66	54	51	57	59	66	63	S. W.	4	. .	Do.
24 Thursday, . .	29·338	66	29·241	70	55	50	59	60	71	68	S. W.	2	·140	Strong, breezy, showery, occasional sun.
25 Friday, . . .	29·762	63	29·674	64	50	47	56	58	64	60	S. W.	6	. .	Fine, breezy, bright sunshine.
26 Saturday, . .	30·100	61	30·015	61	51	47	55	57	62	59	S. W.	6	·050	Breezy, showery, bright sunshine.
27 Sunday, . . .	30·432	64	30·337	65	49	43	56	57	66	61	N. W.	4	. .	Cloudy, mild, occasional sunshine.
28 Monday, . . .	30·400	66	30·299	66	44	40	56	58	68	64	N. W.	7	. .	Fine, breezy, bright sunshine.
29 Tuesday, . .	30·080	65	29·985	66	52	48	58	59	67	63	S. E.	6	. .	Do.
30 Wednesday, .	29·930	70	29·821	70	51	49	60	61	71	67	S. E.	6	. .	Do.
31 Thursday, . .	29·900	70	29·791	71	54	48	61	61	72	65	S. E.	4	. .	Breezy, changeable, occasional sun.
												136	1·310	inches.

SEPTEMBER, 1871.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	Therm.	Corrected.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
		°		°	°	°	°	°	°	°				
1 Friday, . . .	29·996	64	29·902	64	57	53	59	61	64	60	S. W.	2	·060	Cloudy, showery, occasional sunshine.
2 Saturday, . .	30·072	67	29·971	69	47	43	59	61	70	66	S. W.	7	. .	Fine, breezy, bright sunshine.
3 Sunday, . . .	29·720	66	29·621	67	57	52	59	60	67	64	S. W.	2	·080	Breezy, showery, occasional sunshine.
4 Monday, . . .	29·720	66	29·621	67	58	53	59	60	67	64	N.W.	6	. .	Fine, breezy, bright, sunshine day.
5 Tuesday, . . .	30·032	66	29·931	68	47	43	58	60	68	64	N. W.	6	. .	Do.
6 Wednesday, . .	29·950	66	29·851	67	56	51	58	59	68	64	S. W.	4	. .	Breezy, cloudy, occasional sunshine.
7 Thursday, . .	29·900	64	29·806	65	46	42	56	59	66	63	S. W.	6	·140	Breezy, showery, bright sunshine.
8 Friday, . . .	29·750	57	29·677	57	56	51	55	57	57	55	S. W.	0	·160	Cloudy, showery, changeable.
9 Saturday, . .	29·600	54	29·533	56	48	44	53	57	56	53	N. E.	0	·840	Cloudy, wet, changeable.
10 Sunday, . . .	29·740	56	29·667	58	50	45	53	56	59	57	N. E.	0	·660	Breezy, cloudy, wet, changeable.
11 Monday, . . .	30·074	59	29·994	60	50	45	55	57	61	58	N. E.	0	. .	Breezy, foggy, changeable.
12 Tuesday, . . .	30·250	60	30·165	61	50	45	56	58	62	58	N. E.	1	. .	Breezy, occasional sun, changeable.
13 Wednesday, .	30·340	58	30·261	59	53	49	56	58	60	57	N. E.	2	. .	Do.
14 Thursday, . .	30·340	55	30·272	56	50	46	55	57	57	55	N. E.	0	. .	Breezy, cloudy, changeable.
15 Friday, . .	30·250	64	30·155	65	51	48	56	57	66	62	S. E.	5	. .	Fine, mild, bright sunshine.
16 Saturday, . .	30·250	63	30·160	64	51	48	56	57	65	62	N. E.	4	. .	Do.
17 Sunday, . . .	30·250	57	30·176	57	50	46	56	57	57	55	N. E.	0	. .	Breezy, cloudy, changeable.
18 Monday, . . .	30·200	59	30·121	60	49	45	56	57	61	58	N. E.	5	. .	Fine, breezy, bright sunshine.
19 Tuesday, . . .	30·176	59	30·077	60	38	34	54	56	62	59	N. E.	5	. .	Do.
20 Wednesday, . .	29·850	51	29·793	54	38	34	51	54	55	54	S. E.	0	. .	Cloudy, mild, changeable day.
21 Thursday, . .	29·630	52	29·568	54	38	34	50	53	55	54	N. W.	3	·040	Occasional sun, light showers.
22 Friday, . . .	29·760	53	29·698	53	38	34	50	53	54	52	N. W.	3	·080	Do.
23 Saturday, . .	29·772	55	29·705	58	33	29	48	51	58	56	S. E.	6	. .	Fine bright sun, light frost.
24 Sunday, . . .	29·600	47	29·554	47	32	29	45	47	46	45	N. W.	3	·060	Breezy, showery, occasional sunshine.
25 Monday, . . .	29·724	52	29·662	53	40	37	47	49	53	50	N. E.	3	·100	Do.
26 Tuesday, . . .	29·590	52	29·528	53	49	45	48	50	53	50	N.E.	0	. .	Breezy, cloudy, changeable.
27 Wednesday, . .	29·100	49	29·049	50	48	46	48	49	50	48	N.E.	0	1·260	Cloudy, breezy, heavy rain.
28 Thursday, . .	29·590	56	29·517	58	47	44	49	51	58	55	N. W.	4	·160	Breezy, showery, bright sun.
29 Friday, . . .	29·780	50	29·723	52	35	33	47	49	53	50	N.E.	1	. .	Breezy, cloudy, occasional sunshine.
30 Saturday, . .	29·860	50	29·808	53	37	34	46	48	54	51	N. W.	8	·200	Breezy, showery, bright sunshine.
												81	3·790	inches.

OCTOBER, 1871.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Sunday, . . .	29·050	58	28·989	58	45	43	47	49	53	51	S. W.	2	·130	Breezy, showery, occasional sunshine.
2 Monday, . .	29·250	54	29·184	55	41	39	48	50	56	54	S. W.	2	·090	Do.
3 Tuesday, . .	29·440	52	29·389	54	38	36	47	49	55	53	N. W.	3	·040	Do.
4 Wednesday, .	29·660	50	29·604	53	35	32	46	49	55	53	N. W.	4	. .	Fine, breezy, bright sunshine.
5 Thursday, . .	29·660	54	29·594	55	44	41	47	49	56	53	N. W.	2	·080	Breezy, showery, occasional sunshine.
6 Friday, . . .	29·620	50	29·564	50	47	43	47	49	50	48	S. W.	0	·150	Cloudy, wet, changeable day.
7 Saturday, . .	29·600	51	29·544	53	35	32	45	48	53	50	N. W.	4	·250	Breezy, wet, bright sunshine.
8 Sunday, . .	29·972	49	29·920	52	37	33	45	47	53	50	N. W.	4	. .	Fine, breezy, bright sunshine.
9 Monday, . .	30·278	49	30·226	53	32	30	44	47	53	50	N. E.	5	. .	Do.
10 Tuesday, . .	30·390	52	30·327	54	35	33	44	47	54	51	S. E.	2	. .	Breezy, cloudy, occasional sun.
11 Wednesday, .	30·100	53	30·037	55	50	48	47	48	55	52	S. E.	0	. .	Breezy, cloudy, changeable.
12 Thursday, . .	30·262	56	30·152	57	51	49	49	50	57	53	S. E.	0	. .	Do.
13 Friday, . .	30·262	59	30·147	62	51	49	51	52	64	61	S. E.	2	. .	Breezy, cloudy, occasional sunshine.
14 Saturday, . .	30·016	59	29·937	60	51	48	51	52	60	58	S. W.	0	. .	Breezy, cloudy, changeable.
15 Sunday, . . .	29·900	55	29·833	56	53	50	51	52	56	53	S. W.	1	·050	Cloudy, showery, occasional sunshine.
16 Monday, . .	29·840	59	29·762	59	48	46	51	52	60	57	S. W.	0	·400	Cloudy, wet, changeable day.
17 Tuesday, . .	29·750	58	29·672	60	50	48	51	52	61	57	S. W.	1	·140	Breezy, showery, occasional sunshine.
18 Wednesday, .	29·550	58	29·472	58	52	50	51	52	58	56	S. W.	0	. .	Breezy, cloudy, changeable.
19 Thursday, . .	29·500	54	29·433	55	51	49	51	53	56	53	S. W.	0	. .	Cloudy, mild, changeable, rain-like.
20 Friday, . . .	29·820	52	29·758	54	38	36	49	51	55	52	N. W.	4	. .	Fine, breezy, bright sunshine.
21 Saturday, . .	29·590	54	29·908	56	36	34	48	50	57	54	S. W.	1	·110	Breezy, showery, changeable.
22 Sunday, . . .	30·200	57	30·126	59	44	42	47	50	60	57	S. W.	4	. .	Fine, breezy, bright, sunshine.
23 Monday, . .	30·100	60	30·015	61	46	43	47	50	62	59	S. W.	4	. .	Do.
24 Tuesday, . .	30·220	53	30·158	54	44	42	49	51	54	51	N. W.	4	. .	Do.
25 Wednesday, .	30·290	54	30·222	57	39	37	47	49	57	54	S. W.	0	. .	Breezy, cloudy, changeable day.
26 Thursday, . .	30·128	55	30·060	56	53	50	49	51	57	54	S. W.	0	. .	Do.
27 Friday, . . .	29·700	52	29·638	52	51	49	49	51	53	51	S. W.	0	·300	Breezy, cloudy, wet, changeable.
28 Saturday, . .	29·590	45	29·549	47	39	37	46	49	48	46	N. W.	0	·140	Breezy, cloudy, showery, changeable.
29 Sunday, . . .	29·250	51	29·194	52	44	42	47	49	53	50	S. E.	1	·650	Breezy, wet, occasional sunshine.
30 Monday, . .	29·420	52	29·459	53	47	45	48	49	55	51	S. E.	0	·140	Breezy, showery, changeable.
31 Tuesday, . .	29·774	52	29·713	52	49	46	48	50	52	49	S. E.	0	. .	Cloudy, stormy, rain-like.
												50	2·620	inches.

NOVEMBER, 1871.

Date.	Barometer.			Thermometer.							Wind.	Hours of Sunshine.	Rain in Inch.	Weather, and General Remarks.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
	•	°		°	°	°	°	°	°	°				
1 Wednesday, . .	29·966	49	29·914	49	47	46	47	49	50	48	S. E.	0	·240	Breezy, wet, changeable.
2 Thursday, . . .	30·080	48	30·028	49	46	43	46	48	50	48	N. E.	0	. .	Cloudy, mild, changeable.
3 Friday, . . .	30·080	48	30·028	48	46	33	46	48	49	47	N. E.	0	. .	Do.
4 Saturday, . . .	30·100	45	30·058	47	44	42	45	47	47	45	S. E.	0	·070	Breezy, showery, changeable.
5 Sunday, . . .	30·100	48	30·048	49	41	38	45	47	49	47	S. E.	3	. .	Fine, breezy, bright sunshine.
6 Monday, . . .	29·780	42	29·744	44	34	32	43	45	45	43	S. E.	0	. .	Cloudy, cold, changeable.
7 Tuesday, . . .	29·536	45	29·459	47	42	41	48	45	47	45	W.	0	·070	Cloudy, showery, changeable.
8 Wednesday, . .	29·450	45	29·409	47	37	36	42	45	47	45	N. W.	4	. .	Breezy, cold, bright sunshine.
9 Thursday, . . .	29·740	39	29·715	42	30	29	40	43	43	42	N. W.	4	. .	Do.
10 Friday, ...	29·630	41	29·600	42	33	31	39	42	44	42	N. W.	4	. .	Do.
11 Saturday, . . .	29·796	39	29·771	42	29	28	37	40	43	41	N. W.	4	. .	Do.
12 Sunday, . . .	29·876	37	29·856	40	27	26	37	39	42	41	N. W.	4	. .	Fine, breezy, bright sunshine.
13 Monday, . . .	30·120	36	30·100	43	23	22	35	38	44	42	S. E.	0	. .	Cloudy, overcast, changeable.
14 Tuesday, . . .	29·630	49	29·578	50	44	42	44	45	52	50	S. W.	2	·150	Breezy, showery, occasional sunshine.
15 Wednesday, . .	29·826	49	29·774	50	44	42	44	45	51	49	N. W.	0	. .	Breezy, cloudy, changeable.
16 Thursday, . . .	30·120	42	30·084	44	33	31	40	43	44	42	N. W.	4	. .	Fine, breezy, bright sunshine.
17 Friday, ...	30·120	39	30·094	42	34	32	40	43	43	41	N. W.	4	. .	Do.
18 Saturday, . . .	30·150	33	30·141	39	23	21	36	39	41	39	S. E.	4	. .	Fine bright sun, sharp frost.
19 Sunday, . . .	30·140	50	30·082	52	32	29	38	39	52	50	S. W.	2	. .	Fine, breezy, occasional sunshine.
20 Monday, . . .	29·966	51	29·908	51	49	46	42	43	52	50	S. E.	0	. .	Breezy, cloudy, changeable.
21 Tuesday, . . .	29·700	46	29·654	46	46	45	43	44	47	45	S. E.	0	·060	Breezy, showery, changeable.
22 Wednesday, . .	29·890	44	29·849	46	37	35	42	44	47	45	W.	4	·090	Do.
23 Thursday, . .	30·030	46	29·984	49	39	38	41	43	49	46	S. W.	4	. .	Fine, mild, bright sunshine.
24 Friday, ...	29·920	35	29·905	38	31	30	37	40	38	37	S. W.	0	. .	Cloudy, foggy, rain-like day.
25 Saturday, . . .	29·988	42	29·952	43	38	37	39	41	43	41	N. E.	1	100	Cloudy, showery, occasional sun.
26 Sunday, . . .	30·000	42	29·964	43	36	35	39	41	44	42	N. E.	0	·140	Breezy, showery, changeable.
27 Monday, . . .	30·060	41	30·029	42	41	40	39	40	42	40	N. E.	0	·070	Do.
28 Tuesday, . . .	30·040	41	30·009	42	39	38	39	40	42	40	N. E.	0	·100	Cloudy, hail-showers, thunder, lightning.
29 Wednesday, . .	30·000	48	29·964	44	41	39	40	41	45	43	N. E.	2	·060	Cloudy, hail-showers, changeable.
30 Thursday, . .	30·050	37	30·030	38	36	34	38	40	39	37	N. E.	0	·030	Do.
												50	1·180	inches.

DECEMBER, 1871.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth 5 in.	THERMOMETER. In Earth 10 in.	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER AND GENERAL REMARKS.
		°		°	°	°	°	°	°	°				
1 Friday, . . .	30·250	38	30·224	40	35	33	38	40	41	39	N. E.	0	. .	Cloudy, cold, changeable day.
2 Saturday, . .	30·280	38	30·254	40	33	31	37	39	42	40	S. W.	3	. .	Fine, breezy, bright sunshine.
3 Sunday, . .	30·080	38	30·054	40	34	32	36	38	41	39	N. E.	0	. .	Breezy, cloudy, changeable day.
4 Monday, . .	30·250	33	30·241	35	30	28	35	37	36	35	N. E.	3	. .	Breezy, showers of hail, bright sun.
5 Tuesday, . .	30·270	29	30·269	30	23	21	32	35	32	30	N. W.	0	. .	Breezy, cold, sharp frost.
6 Wednesday, .	30·160	34	30·145	36	32	30	33	35	36	35	N. W.	2	. .	Breezy, changeable, occasional sunshine.
7 Thursday, . .	30·200	36	30·180	38	30	28	33	35	38	36	N. W.	0	·020	Breezy, showery, changeable day.
8 Friday, . . .	30·350	32	30·341	33	31	29	32	34	33	32	N. W.	0	. .	Cloudy, cold, changeable day.
9 Saturday, .	30·278	35	30·263	37	33	31	34	36	38	36	N. W.	1	. .	Cloudy, cold, occasional sunshine.
10 Sunday, . .	30·250	40	30·219	43	31	30	35	36	43	41	S. W.	2	. .	Fine, breezy, bright sunshine.
11 Monday, . .	30·380	45	30·338	47	40	38	37	38	48	46	S. W.	2	. .	Do.
12 Tuesday, . .	30·280	45	30·238	47	39	37	38	40	48	46	S. W.	0	. .	Breezy, cloudy, changeable.
13 Wednesday, .	30·340	45	30·298	46	45	43	40	41	47	45	S. W.	0	·120	Breezy, showery, changeable.
14 Thursday, . .	30·290	48	30·238	50	44	42	41	42	50	48	S. W.	1	.	Fine, mild, occasional sunshine.
15 Friday, . . .	30·132	47	30·085	48	42	40	41	42	49	47	S. W.	1	. .	Breezy, changeable, occasional sunshine.
16 Saturday, . .	30·328	40	30·297	43	34	32	40	42	42	41	S. W.	1	. .	Do.
17 Sunday, . . .	30·040	47	29·993	48	33	31	39	41	49	47	S. W.	1	·050	Breezy, cloudy, changeable.
18 Monday, . .	29·560	52	29·498	52	48	46	42	44	53	51	S. W.	0	·060	Strong breeze, light showers.
19 Tuesday, . .	29·760	45	29·719	45	39	37	41	43	46	44	S. W.	2	. .	Fine, breezy, bright sunshine.
20 Wednesday, .	29·240	40	29·210	40	39	37	41	43	40	39	S. E.	0	·170	Breezy, wet, changeable.
21 Thursday, . .	29·590	40	29·560	42	35	34	40	41	43	41	S. W.	0	·040	Cloudy, overcast, light showers.
22 Friday, . . .	29·824	41	29·794	44	39	36	38	40	44	42	N. W.	0	·040	Do.
23 Saturday, . .	29·996	41	29·966	43	39	36	38	40	44	42	S. E.	1	. .	Cloudy, changeable, occasional sun.
24 Sunday, . .	29·738	49	29·676	50	43	41	42	44	50	48	S. W.	0	·040	Cloudy, showery, changeable.
25 Monday, . .	29·738	40	29·708	41	40	39	41	42	42	40	S. W.	0	·290	Cloudy, wet, changeable day.
26 Tuesday, . .	29·432	46	29·386	49	33	32	40	42	50	48	S. W.	1	. .	Breezy, cloudy, occasional sunshine.
27 Wednesday, .	29·260	40	29·230	42	38	36	39	41	42	42	S. W.	2	. .	Do.
28 Thursday, . .	29·060	43	29·024	44	40	39	40	42	44	43	S. W.	0	·070	Cloudy, showery, changeable.
29 Friday, . . .	29·590	43	29·554	46	32	30	37	40	46	44	S. W.	3	. .	Fine, breezy, bright sunshine.
30 Saturday, . .	29·536	46	29·490	48	42	40	40	42	49	47	S. W.	2	·110	Breezy, showery, occasional sunshine.
31 Sunday, . .	29·928	40	29·898	43	33	31	38	40	44	43	S. W.	3	·050	Breezy showery, bright sun.
												31	1·060	inches.

JANUARY, 1872.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	Therm.	Cor-rected.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
		°		°	°	°	°	°	°	°				
1 Monday, . . .	29·550	41	29·509	44	43	41	38	40	45	43	S. W.	0	·210	Cloudy, stormy, heavy showers.
2 Tuesday, . . .	29·460	44	29·419	45	41	40	40	42	44	43	S. W.	2	·	Fine, breezy, bright sunshine.
3 Wednesday, . .	29·662	40	29·632	44	35	33	38	40	44	43	S. W.	3	· ·	Do.
4 Thursday, . . .	29·098	37	29·069	38	35	33	37	39	38	37	S. W.	0	·390	Breezy, wet, changeable.
5 Friday, . . .	28·830	37	28·810	39	36	35	37	39	40	38	S. W.	0	·280	Do.
6 Saturday, . .	29·250	39	29·225	42	32	30	35	37	42	40	S. W.	3	·230	Breezy, snow showers, bright sun.
7 Sunday, . . .	29·100	38	29·075	42	33	31	35	38	42	40	S. W.	0	·	Breezy, cloudy, changeable day.
8 Monday, . . .	29 496	36	29·476	39	33	31	34	37	40	38	S. W.	3	· ·	Fine, breezy, bright sunshine.
9 Tuesday, . . .	2 ·678	37	29·658	40	32	39	34	36	40	38	N. W.	3	· ·	Do.
10 Wednesday, . .	29·780	42	29·744	45	30	28	35	37	46	44	S. W.	0	·190	Breezy, showery, changeable.
11 Thursday, . . .	29·650	47	29·601	49	43	41	39	40	50	48	S. W.	3	·150	Breezy, showery, bright sunshine.
12 Friday, ...	29·850	46	29·804	48	32	30	38	40	49	47	S. W.	0	· .	Breezy, cloudy, changeable.
13 Saturday, . . .	29·416	51	29·360	52	46	44	41	43	52	49	S. E.	0	·100	Breezy, cloudy, showery, changeable.
14 Sunday, . . .	29·900	41	29 870	43	36	34	39	41	44	42	N. W.	3	·050	Stormy, light showers. bright sun.
15 Monday, . . .	29·750	42	29·714	44	33	31	38	39	45	43	S. E.	0	· ·	Breezy, cloudy, changeable.
16 Tuesday, . . .	29·726	36	29·706	41	30	28	36	88	42	40	S. W.	0	· ·	Do.
17 Wednesday, . .	29·000	49	28·949	51	41	39	40	42	52	49	S. W.	0	·280	Breezy, showery, changeable.
18 Thursday, . . .	28·890	40	28·861	41	38	36	39	41	42	40	S. W.	3	· ·	Fine, breezy, bright sunshine.
19 Friday, . . .	29·236	42	29·200	46	34	32	37	39	47	45	S. W.	3	· ·	Do.
20 Saturday, . . .	29·520	36	29·500	40	29	28	35	37	40	39	N. W.	2	· ·	Breezy, occasional sunlight, frost.
21 Sunday, . . .	29·550	31	29·546	34	26	24	33	34	35	34	N. E.	0	· ·	Breezy, foggy, changeable.
22 Monday, . . .	29·300	41	29·270	41	31	29	35	37	42	40	S. E.	0	060	Breezy, showery, changeable day.
23 Tuesday, . . .	28·582	43	28·553	43	41	40	37	39	44	41	S. E.	0	·300	Breezy, heavy rain, changeable.
24 Wednesday, . .	28 500	34	28·486	38	31	29	35	36	40	39	S. E.	1	·110	Cloudy, foggy, occasional sunshine.
25 Thursday, . .	28 700	40	28·671	42	38	36	35	37	42	40	N. E.	0	·050	Cloudy, showery, changeable.
26 Friday, ...	29·450	42	29·415	44	39	37	36	38	45	43	N. E.	2	·040	Breezy, showery, occasional sunshine.
27 Saturday, . . .	29·908	40	29·878	42	36	34	37	39	42	40	N. W.	3	· ·	Fine, breezy, bright sunshine.
28 Sunday, . . .	29·758	42	29·722	45	29	27	36	38	45	43	S. W.	3	·030	Breezy, light showers, bright sunshine.
29 Monday, . . .	29·830	52	29·768	53	44	42	39	40	53	51	S. W.	3	·050	Do.
30 Tuesday, . . .	29·490	54	29·424	55	48	46	43	44	56	53	S. W.	1	·070	Breezy, showery, occasional sunshine.
31 Wednesday, . .	29·414	49	29·363	50	44	42	42	44	51	48	S. E.	0	· ·	Breezy, cloudy, changeable day.
												41	2·590	Inches.

FEBRUARY, 1872.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	Therm.	Corrected.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
		°		°	°	°	°	°	°	°				
1 Thursday, . .	29·328	50	29·272	52	45	43	43	44	54	51	S. W.	3	·360	Breezy, heavy rain, bright sunshine.
2 Friday, ...	29·432	47	29·383	50	39	37	42	44	51	49	S. W.	4	·100	Breezy, showery, bright sunshine.
3 Saturday, . . .	29·568	44	29·527	46	37	35	40	42	46	45	S. W.	1	·030	Breezy, light showers, occasional sun.
4 Sunday, . . .	29·550	45	29·509	47	38	36	39	41	48	46	S. W.	2	·280	Breezy, heavy showers, occasional sun.
5 Monday, . . .	29·380	44	29·340	45	42	40	39	41	46	44	S. W.	2	·330	Do.
6 Tuesday, . . .	29·580	49	29·498	52	40	39	41	43	53	50	S. E.	4	·160	Breezy, showery, bright sunshine.
7 Wednesday, . .	29·800	41	29·770	46	31	29	39	41	48	46	S. W.	4	. .	Fine, breezy, bright sunshine.
8 Thursday, . .	29·800	44	29·759	45	42	40	39	41	46	44	S. E.	0	·020	Breezy, light showers, changeable.
9 Friday, ...	29·628	50	29·571	54	45	43	42	43	53	50	S. W.	3	·100	Breezy, showery, bright sunshine.
10 Saturday, . . .	29·628	49	29·576	50	46	44	42	44	51	49	S. E.	0	. .	Breezy, cloudy, changeable day.
11 Sunday, . . .	29·650	46	29·604	48	39	37	41	42	49	47	S. E.	1	·020	Breezy, light showers, occasional sunshine.
12 Monday, . . .	29·380	47	29·334	47	45	43	41	42	48	46	S. E.	0	·170	Breezy, wet, changeable day.
13 Tuesday, . .	29·490	46	29·444	46	44	42	42	43	46	44	S. E.	0	·260	Do.
14 Wednesday, . .	29·550	45	29·509	46	44	42	42	44	46	44	S. E.	1	·090	Breezy, showery, occasional sunshine.
15 Thursday, . .	29·650	46	29·604	49	44	42	43	45	50	47	S. E.	4	. .	Fine, breezy, bright sunshine.
16 Friday, ...	29·600	44	29·559	46	37	34	41	43	47	45	S. W.	1	·080	Breezy, showery, occasional sunshine.
17 Saturday, . . .	29·550	44	29·509	46	37	34	41	43	47	45	S. W.	1	. .	Breezy, changeable, occasional sunshine.
18 Sunday, . . .	29·480	44	29·440	47	36	35	39	41	47	45	S. W.	2	·030	Breezy, showery, occasional sunshine.
19 Monday, . .	29·550	45	29·509	49	34	32	39	41	49	46	S. W.	4	. .	Fine, breezy, bright sunshine.
20 Tuesday, . . .	29·686	46	29·622	46	37	35	39	41	46	44	S. W.	1	·020	Breezy, light showers, occasional sun.
21 Wednesday, . .	29·936	45	29·895	48	36	34	39	40	49	47	S. W.	4	. .	Fine, breezy, bright sunshine.
22 Thursday, . .	29·700	49	29·648	49	44	42	41	43	50	48	S. E.	0	. .	Breezy, cloudy, changeable day.
23 Friday, ...	29·700	48	29·648	51	39	37	41	43	51	48	S. E.	4	. .	Fine, mild, bright sunshine.
24 Saturday, . . .	29·228	52	29·167	53	44	41	42	44	54	51	S. W.	0	·140	Cloudy, mild, showery, changeable.
25 Sunday, . . .	29·226	50	29·170	51	42	40	43	44	52	49	S. W.	2	·070	Breezy, showery, occasional sun.
26 Monday, . . .	29·748	45	29·707	46	43	41	42	44	47	45	S. W.	0	. .	Breezy, cloudy, changeable.
27 Tuesday, . . .	30·130	41	30·099	42	39	37	41	43	43	41	S. W.	0	. .	Do.
28 Wednesday, . .	29·800	43	29·760	44	35	34	39	41	44	43	S. E.	0	. .	Do.
29 Thursday, . .	29·714	55	29·348	56	43	41	43	44	56	53	S. W.	2	·100	Do.
												50	2·360	inches.

MARCH, 1872.

DATE.	BAROMETER.			THERMOMETER							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P.M.	Observed Height.	Therm.	Corrected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Friday, ...	29·650	52	29·488	53	47	45	42	44	58	50	S. W.	1	·250	Breezy, heavy showers, occasional sunshine
2 Saturday, . .	29·800	50	29·743	50	37	36	43	45	52	49	S. W.	0	·030	Breezy, cloudy, light showers.
3 Sunday, . . .	30·050	56	29·967	59	46	44	45	46	60	57	S. E.	4	. .	Fine, breezy, bright, sunshine day.
4 Monday, . . .	29·968	57	29·894	57	48	46	46	47	58	55	S. W.	5	. .	Do.
5 Tuesday, . . .	29·820	51	29·763	51	50	49	46	47	51	49	S. W.	0	. .	Breezy, cloudy, changeable day.
6 Wednesday, .	29·650	53	29·558	54	46	44	46	47	55	51	S. E.	5	. .	Fine, breezy, bright sunshine day.
7 Thursday, . .	22·250	49	29·199	51	45	43	45	46	52	49	S. E.	3	. .	Breezy, changeable, occasional sunshine.
8 Friday, . . .	29·250	48	29·199	48	44	42	44	46	48	46	S. W.	2	·110	Breezy, showery, occasional sunshine.
9 Saturday, . .	29·976	44	29·933	45	32	30	41	43	46	44	N. W.	4	. .	Fine, breezy, bright sunshine day.
10 Sunday, . . .	30·140	43	30·104	48	29	27	40	42	49	47	S. W.	2	. .	Breezy, occasional sun, light frost.
11 Monday, . . .	30·000	50	29·942	51	42	40	42	44	51	49	S. W.	0	·030	Breezy, showery, changeable day.
12 Tuesday, . . .	29·878	48	29·826	50	43	41	43	45	52	50	S. W.	2	·100	Breezy, showery, occasional sun.
13 Wednesday, . .	29·680	47	29·634	49	37	36	42	44	50	48	S. W.	2	·110	Do.
14 Thursday, . .	29·300	48	29·248	51	37	36	42	44	52	49	S. W.	2	·050	Do.
15 Friday, ...	29·600	48	29·548	51	31	29	41	43	52	49	S. W.	4	. .	Fine, breezy, bright sunshine day.
16 Saturday, . . .	29·850	54	29 783	55	44	42	44	45	56	53	N. W.	4	·040	Fine, bright sun, light showers.
17 Sunday, . . .	29·746	52	29·686	52	48	46	45	47	53	50	S. W.	0	·040	Breezy, cloudy, light showers.
18 Monday, . . .	29·886	48	29·834	50	38	36	43	45	51	49	S. W.	3	·080	Breezy, light showers, occasional sun.
19 Tuesday, . . .	30·050	47	30·004	47	41	39	42	44	47	45	N. W.	2	. .	Breezy, cloudy, occasional sunshine.
20 Wednesday, .	29·950	44	29·909	48	36	34	42	43	49	47	N. E.	2	. .	Do.
21 Thursday, . .	29·800	38	29·775	40	28	26	39	42	41	40	N. E.	2	. .	Breezy, occasional sun, light frost.
22 Friday, . . .	29·940	37	29·920	39	32	30	38	40	40	39	N. E.	0	. .	Breezy, cold snow, showers, changeable.
23 Saturday, . .	29·940	37	29·920	37	33	31	37	38	37	36	N. E.	0	·360	Do.
24 Sunday, . . .	29·700	35	29·685	36	34	33	36	38	37	36	N. E.	0	·370	Breezy, cloudy, snow showers.
25 Monday, . . .	29·650	38	29·625	40	34	33	37	39	40	39	N. W.	3	·190	Breezy, occasional sun, snow showers.
26 Tuesday, . .	29·450	41	29·410	44	31	29	37	39	44	42	N. W.	3	·090	Do.
27 Wednesday, .	29·150	36	29·130	37	34	32	36	37	38	37	N. E.	0	·400	Breezy, heavy rain, snow showers.
28 Thursday, . .	29·088	40	29·030	42	37	36	39	40	43	41	N. E.	0	·200	Do.
29 Friday, . . .	29·100	52	29·039	58	42	40	42	43	54	51	S. E.	0	·150	Cloudy, mild, light showers.
30 Saturday, . .	29·140	50	29·084	51	45	42	43	44	52	49	S. E.	1	·140	Cloudy, heavy showers, occasional sun.
31 Sunday, . .	29·388	47	29·343	47	48	46	44	45	48	46	S. E.	0	·420	Breezy, wet, changeable day.
												56	3·160	Inches.

APRIL, 1872.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	Therm.	Corrected.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH	WEATHER, AND GENERAL REMARKS.
1 Monday, . .	29·400	° 48	29·349	° 51	° 35	° 34	° 44	° 45	° 52	° 49	S. E.	0	·050	Breezy, cloudy, light showers.
2 Tuesday, . .	29 642	42	29·606	45	39	37	42	44	47	45	N. E.	1	·550	Breezy, wet, occasional sun.
3 Wednesday, .	29·780	45	29·739	47	34	33	42	44	48	46	N. E.	6	. .	Fine, breezy, bright sunshine.
4 Thursday, . .	30·100	48	30·048	51	31	30	42	44	51	49	N.W.	6	. .	Do.
5 Friday, . . .	30·300	47	30·253	50	31	30	41	43	51	49	N. E.	2	. .	Breezy, cloudy, occasional sunshine.
6 Saturday, . .	30 350	51	30·292	55	39	37	43	45	57	55	S. E.	1	. .	Cloudy, mild, occasional sunshine.
7 Sunday, . . .	30·280	57	30·206	59	49	47	46	47	60	57	S. E.	1	. .	Breezy, cloudy, occasional sunshine.
8 Monday, . . .	30·174	53	30 111	54	51	49	45	47	55	53	S. W.	0	·060	Breezy, light showers, changeable.
9 Tuesday, .	30·290	52	30·227	55	36	34	45	47	57	54	S. W.	6	. .	Fine, breezy, bright sunshine.
10 Wednesday, .	30·140	55	30·072	56	43	41	47	49	57	54	S. W.	6	. .	Do.
11 Thursday, .	29·842	54	29·775	57	44	42	48	50	56	54	S. W.	2	. .	Breezy, cloudy, occasional sunshine.
12 Friday, . . .	29·696	58	29·634	54	43	41	46	48	55	53	N. W.	6	. .	Fine, breezy, bright sunshine.
13 Saturday, . .	30·226	52	30·163	53	37	35	45	46	54	51	N. W.	5	. .	Do.
14 Sunday, . . .	30·250	54	30·182	57	38	36	46	48	57	54	N. W.	6	. .	Fine, breezy, bright sunshine.
15 Monday, . .	30·128	53	30·056	55	36	35	46	48	57	54	N. W.	4	. .	Breezy, cloudy, occasional sunshine.
16 Tuesday, . .	30·128	52	30 056	53	36	34	45	46	53	51	N. W.	3	. .	Do.
17 Wednesday, .	29·768	48	29·696	49	41	39	43	44	50	48	N. W	3	. .	Do.
18 Thursday, . .	30·040	45	29·998	46	39	37	42	44	46	44	N. E.	3	·060	Breezy, light showers, occasional sun.
19 Friday, . . .	30 000	44	29·958	45	34	32	42	44	46	41	N. E.	1	. .	Breezy, showers of hail, changeable.
20 Saturday, . .	29·440	40	29·410	41	38	37	41	42	41	39	S. E.	0	·220	Breezy, wet, changeable day.
21 Sunday, . . .	29·450	40	29·420	41	37	36	40	41	42	40	N. E.	0	·060	Breezy, showery, changeable day.
22 Monday, . .	29·124	44	29·084	47	38	36	41	42	49	47	N. E.	2	1·500	Stormy, heavy rain, occasional sun.
23 Tuesday, . .	29·092	45	29 052	46	43	41	42	43	46	44	N. E.	0	·180	Breezy, cloudy, showery, changeable.
24 Wednesday, .	29·300	52	29·239	56	44	42	44	45	58	55	S. W.	2	·060	Breezy, light showers, occasional sun.
25 Thursday, . .	29·520	54	29·453	57	41	38	45	46	58	55	S. W.	3	·040	Do.
26 Friday, . . .	29·600	55	29·533	55	44	41	45	47	56	54	S. E.	4	·080	Do.
27 Saturday, . .	29·800	55	29·733	58	38	36	47	48	58	55	S. E.	4	. .	Cloudy, mild, occasional sunshine.
28 Sunday, . . .	29·950	53	29·888	55	36	34	46	47	57	54	S. W.	5	. .	Fine, breezy, bright sunshine.
29 Monday, . .	30·250	55	30·182	59	41	39	47	49	61	57	S. W.	5	·040	Breezy, showery, bright sunshine.
30 Tuesday, . .	30·300	63	30·210	63	51	49	50	51	64	61	S. E.	3	. .	Breezy, cloudy, occasional sunshine.
												100	2·900	inches.

MAY, 1872.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected	Max.	Min.	On Grass.	In earth. 5 in.	In earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Wednesday, . .	30·236	60	30·151	61	50	49	50	51	61	57	S. E.	0	·050	Breezy, showery, changeable.
2 Thursday, . . .	30·236	60	30·151	61	51	50	51	52	62	57	S. W.	6	. .	Fine, breezy, bright sunshine.
3 Friday, ...	29·730	59	29·652	61	46	44	51	52	62	57	S. W.	2	·060	Brisk breeze, showers, occasional sun.
4 Saturday, . . .	29·250	52	29·189	53	44	42	48	50	53	50	N. W.	2	·080	Do.
5 Sunday, . . .	29·532	52	29·470	58	40	38	47	49	54	51	S. W.	4	·040	Breezy, showery, occasional sunshine.
6 Monday, . . .	29·420	47	29·375	48	41	39	46	47	48	46	S. W	0	·060	Cloudy, showery, changeable day.
7 Tuesday, . . .	29·220	49	29·169	49	43	41	44	46	50	47	N. W.	0	·210	Do.
8 Wednesday, . .	29·374	50	29·318	53	41	40	45	47	54	51	N. W.	3	·070	Cloudy, showers of hail, occasional sun.
9 Thursday, . . .	29·860	52	29·798	55	37	35	45	47	56	54	N. W.	5	. .	Fine, breezy, bright sunshine.
10 Friday, ...	30·250	48	30·198	50	35	33	45	47	51	49	N. E.	0	·190	Cloudy, showers of hail, changeable.
11 Saturday, . . .	30·220	50	30·142	52	40	38	46	48	53	50	N. E.	2	. .	Breezy, changeable, occasional sunshine.
12 Sunday, . . .	30·000	44	29·958	47	35	33	43	46	48	46	N. E.	0	·110	Cloudy, showery, changeable.
13 Monday, . . .	30·074	51	30·016	52	37	35	44	46	53	50	N. E.	5	. .	Fine, breezy, bright sunshine.
14 Tuesday, . . .	29·878	51	29·817	52	41	39	47	48	53	50	N. E.	0	·070	Breezy, showery, changeable.
15 Wednesday, . .	29·838	54	29·771	52	48	46	48	50	52	49	N. E.	0	·060	Cloudy, showery, changeable.
16 Thursday, . . .	29·838	56	29·765	56	41	39	49	51	57	54	S. E.	6	·230	Breezy, bright sun, heavy showers.
17 Friday, ...	29·712	51	29·655	51	44	43	49	51	52	49	S. E.	0	. .	Breezy, cloudy, changeable.
18 Saturday, . . .	29·762	44	29·721	46	41	39	47	49	47	45	N. E.	0	·110	Cloudy, showery, changeable.
19 Sunday, . . .	29·738	48	29·686	49	31	29	44	46	50	48	S. W.	3	·060	Cloudy, showers of hail, occasional sun.
20 Monday, . . .	29·738	52	29·681	52	32	30	44	46	53	50	S. E.	6	. .	Fine, breezy, bright sunshine.
21 Tuesday, . . .	29·790	52	29·733	54	41	40	47	49	55	51	S. W.	3	·120	Cloudy, showers, occasional sunshine.
22 Wednesday, .	29·800	52	29·738	52	37	35	46	47	52	50	N. W.	3	·370	Showers of hail, thunder, lightning, sun.
23 Thursday, . . .	29·870	52	29·808	53	40	38	46	48	54	51	S. E.	3	·160	Cloudy, showery, occasional sunshine.
24 Friday, ...	30·040	54	29·972	56	43	41	47	49	56	53	N. W.	1	·290	Breezy, showers of hail, occasional sun.
25 Saturday, . . .	30·184	56	30·110	57	48	47	48	50	58	54	N. W.	0	. .	Cloudy, showery-like day.
26 Sunday, . . .	30·350	61	30·295	62	47	45	51	52	63	59	S. W.	6	. .	Fine, breezy, bright sunshine day.
27 Monday, . . .	30·350	58	30·271	59	51	49	51	52	59	56	S. W.	0	. .	Breezy, cloudy, changeable day.
28 Tuesday, . . .	30·250	57	30·176	59	47	45	51	52	60	57	S. W.	3	. .	Breezy, cloudy, occasional sunshine.
29 Wednesday, . .	29·960	58	29·882	57	52	50	51	52	57	55	S. W.	0	·100	Breezy, showery, changeable.
30 Thursday, . . .	29·986	55	29·919	56	47	46	51	53	56	54	S. W.	3	. .	Breezy, cloudy, occasional sunshine.
31 Friday, ...	29·986	55	29·919	55	45	43	49	52	55	53	N. W.	3	·020	Breezy, light showers, occasional sun.
												69	2·460	inches.

JUNE, 1872.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	Therm.	Corrected.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
		°		°	°	°	°	°	°	°				
1 Saturday, . .	30·050	54	29·982	53	38	36	48	50	53	50	S. W.	2	·070	Breezy, light showers, occasional sun.
2 Sunday, . . .	29·750	58	29·672	59	49	47	50	51	60	57	S. W.	2	·570	Breezy, heavy rain, occasional sun.
3 Monday, . .	99·840	54	29·773	55	45	43	49	50	55	53	S. W.	2	·130	Breezy, showery, occasional sun.
4 Tuesday, . . .	30·094	54	30·026	56	44	42	48	51	57	54	S. W.	2	·030	Breezy, light showers, occasional sun.
5 Wednesday, .	29·980	54	29·911	57	52	50	50	52	58	54	N. W.	1	·220	Cloudy, showery, occasional sunshine.
6 Thursday, . .	29·864	56	29·791	58	39	37	48	51	58	54	S. E.	5	·040	Breezy, light showers, occasional sun.
7 Friday, . . .	29·578	54	29·511	56	40	39	50	51	57	55	S. E.	5	·050	Do.
8 Saturday, . .	29·400	54	23·334	54	39	37	49	51	55	53	S. E.	8	·100	Breezy, heavy showers, bright sun.
9 Sunday, . . .	29·150	51	29·094	51	46	44	49	51	52	50	N. W.	0	·460	Cloudy, heavy rain, changeable.
10 Monday, . . .	29·492	54	29·426	54	47	45	49	51	54	51	N. W.	0	·250	Breezy, heavy showers, changeable.
11 Tuesday, . . .	29·614	60	29·531	61	47	45	50	52	62	59	S. E.	2	·170	Cloudy, showery, occasional sunshine.
12 Wednesday, .	29·750	58	29·672	59	50	48	51	53	60	57	S. W.	0	·040	Breezy, cloudy, light showers.
13 Thursday, . .	29·900	64	29·906	64	54	51	53	54	64	61	S. E.	3	[illegible]	Breezy, cloudy, occasional sunshine.
14 Friday, . . .	29·972	61	29·889	62	48	46	54	55	63	60	S. E.	2	[illegible]	Do.
15 Saturday, . .	30·040	66	29·939	69	54	52	56	57	70	67	S. W.	2	·550	Breezy, heavy rain, occasional sun.
16 Sunday, . . .	30·218	67	30·117	[illegible]	57	55	57	59	70	67	S. W.	3	[illegible]	Breezy, cloudy, occasional sunshine.
17 Monday, . . .	30·150	64	30·055	66	56	54	58	59	68	64	S. W.	0	·330	Breezy, cloudy, heavy showers
18 Tuesday, . .	29·900	71	29·791	69	55	53	60	61	70	67	S. E.	6	[illegible]	Breezy, changeable, bright sunshine.
19 Wednesday, .	29·800	61	29·717	61	58	56	59	61	61	58	N. W.	0	·030	Breezy, cloudy, light showers.
20 Thursday, .	30·050	66	29·949	68	49	47	57	60	68	64	S. W.	6	[illegible]	Fine, breezy, bright sunshine.
21 Friday, . . .	29·750	60	29·667	62	50	49	57	59	63	60	S. E.	0	[illegible]	Breezy, cloudy, rain-like day.
22 Saturday, . .	29·930	59	29·852	59	48	46	54	57	60	58	S. W.	4	·040	Breezy, showery, occasional sunshine.
23 Sunday, . . .	30·000	66	29·899	67	50	49	56	57	68	65	S. W.	6	·100	Breezy, showery, bright sunshine.
24 Monday, . .	29·674	59	29·596	59	53	[illegible]	56	58	60	57	S. W.	0	·080	Breezy, showery, cloudy, changeable.
25 Tuesday, . .	29·524	58	29·446	58	54	52	55	57	58	56	S. W.	0	·030	Breezy, cloudy, light showers.
26 Wednesday, .	29·700	58	29·622	60	43	41	55	57	61	58	S. W.	3	·050	Breezy, showery, occasional sun.
27 Thursday, . .	29·844	58	29·766	60	46	44	54	57	61	58	S.	0	·170	Cloudy, showery, changeable.
28 Friday, . .	29·734	62	29·655	61	54	52	55	57	62	59	S. W.	6	·040	Breezy, light showers, bright snn.
29 Saturday, . .	30·000	62	29·912	63	45	43	54	56	65	61	S. W.	6	[illegible]	Fine, breezy, bright sunshine
30 Sunday, . . .	29·750	62	29·662	61	47	45	54	56	62	59	S. E.	6	[illegible]	Breezy, cloudy, occasional sunshine.
												75	3·650	inches.

JULY, 1870.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HORUS OF SUNSHINE	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Cor-rected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Monday, . . .	29·750	64	29.656	65	49	48	55	57	66	63	S. W.	6	·030	Breezy, light showers, occasional sun.
2 Tuesday, . . .	30·000	62	29 910	63	47	45	54	56	64	61	S. W.	3	·080	Cloudy, showery, occasional sun.
3 Wednesday,. .	30·150	69	30 029	71	48	47	57	59	73	69	S. W.	8	. .	Fine, breezy, bright sunshine.
4 Thursday, . .	30·226	74	30·104	75	57	56	61	62	77	73	S. E.	8	. .	Do.
5 Friday, . . .	30·038	73	29·921	74	55	53	62	63	75	72	S. E.	8	. .	Do.
6 Saturday, . .	29·940	62	29·952	62	56	54	61	62	63	60	N. E.	2	·070	Cloudy, light showers, occasional sun.
7 Sunday, . . .	29 844	55	29·777	56	49	47	57	59	56	54	N. E	0	·110	Breezy, cloudy, occasional heavy showers.
8 Monday, . . .	29·800	63	29·712	64	50	48	56	58	64	61	S. W.	3	·090	Breezy, light showers, occasional sun.
9 Tuesday, . . .	29·868	64	29·764	65	54	52	57	59	67	63	S. W.	4	·100	Do.
10 Wednesday, .	29·750	59	29·672	58	49	46	56	58	58	56	S. E.	0	·060	Breezy, cloudy, light showers.
11 Thursday, . .	29·750	64	29·656	64	48	47	56	58	65	63	S. E.	5	. .	Breezy, bright sun, changeable.
12 Friday, . . .	29·900	67	29·801	68	49	47	59	60	70	66	N. E.	7	. .	Fine, breezy, bright sunshine.
13 Saturday, . .	29·886	64	29·792	63	51	49	58	60	63	60	N. E.	1	·060	Cloudy, light showers, occasional sun.
14 Sunday, . . .	30·040	71	29·929	72	54	53	62	63	74	71	N. E.	8	. .	Fine, breezy, bright sunshine.
15 Monday, . . .	30·000	59	29·921	62	52	50	59	61	63	61	S. W.	0	. .	Breezy, cloudy, changeable.
16 Tuesday, . .	29·900	69	29 796	70	46	45	59	61	72	69	S. E.	8	. .	Fine, breezy, bright sunshine.
17 Wednesday,. .	29·950	69	29·846	68	55	53	62	63	70	67	S. E.	8	. .	Do.
18 Thursday, . .	29·950	68	29·846	68	54	52	60	62	69	66	S. W.	4	. .	Breezy, cloudy, occasional sunshine.
19 Friday, . . .	30 000	64	29·905	65	55	54	61	62	66	64	S. E.	0	. .	Breezy, cloudy, changeable.
20 Saturday, . .	29·940	75	29·818	76	56	55	61	62	76	72	S. E.	6	. .	Fine, breezy, bright sunshine.
21 Sunday, . . .	29·900	74	29·780	74	56	54	64	64	75	72	S. W.	5	. .	Breezy, cloudy, occasional sunshine.
22 Monday, . . .	29·884	72	29·769	74	60	58	64	64	77	74	S. W.	5	. .	Do.
23 Tuesday, . . .	29·700	65	29·606	67	57	56	63	64	69	66	S. E.	4	. .	Do.
24 Wednesday,. .	29·868	67	29·769	67	56	54	62	63	68	65	S. E.	4	. .	Do.
25 Thursday, . .	29·900	61	29·817	62	54	52	60	62	63	60	S. E.	0	·050	Cloudy, light showers, changeable.
26 Friday, . . .	29 750	68	29 646	70	50	48	62	63	72	69	S. E.	2	·360	Breezy, with thunder storm, bright sun.
27 Saturday, . .	29·900	69	29·796	69	56	54	62	63	70	67	S. E.	3	·030	Breezy, showery, occasional sunshine.
28 Sunday, . . .	29·868	65	29·774	68	58	56	61	62	69	66	S. E.	0	·030	Breezy, cloudy, light showers.
29 Monday, . . .	29·750	66	29·651	68	57	55	62	63	69	66	S. E.	5	·180	Breezy, heavy showers, occasional sun.
30 Tuesday, . . .	29·850	60	29 767	61	54	52	60	61	61	59	N. E.	0	. .	Breezy, cloudy, changeable.
31 Wednesday,. .	29 960	64	29·866	65	47	45	58	61	66	63	S. E.	6	. .	Fine, breezy, bright sunshine.
												123	3·650	Inches.

AUGUST, 1872.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN. IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Thursday, . .	29·828	62	29·740	63	51	49	58	61	65	62	N. E.	4	. .	Breezy, cloudy, occasional sunshine.
2 Friday, . . .	29·700	55	29·633	56	51	49	57	60	57	55	N. W.	0	·480	Breezy, wet, changeable day.
3 Saturday, . .	29·850	56	29·777	57	48	46	56	58	59	57	N. W.	2	·070	Cloudy, showery, occasional sunshine.
4 Sunday, . . .	29·850	60	29·767	61	48	46	56	58	61	59	S. E.	2	. .	Breezy, cloudy, occasional sunshine.
5 Monday, . . .	29·500	56	29·427	57	54	52	55	57	57	55	S. E.	0	·460	Breezy, wet, changeable.
6 Tuesday, . .	29·588	64	29·484	65	48	46	56	58	66	63	S. E.	4	·350	Cloudy, showery, occasional sun.
7 Wednesday, .	29·530	62	29·442	63	46	45	56	58	66	63	S. E.	2	·940	Breezy, heavy rain, thunder lightning.
8 Thursday, . .	29·896	62	29·808	62	48	46	56	59	64	61	N. W.	6	. .	Fine, breezy, bright sunshine.
9 Friday, . . .	29·896	62	29·808	62	53	51	57	59	64	61	S. E.	2	·070	Breezy, cloudy, light showers, occasional sun.
10 Saturday, . .	29·350	64	29·258	66	52	50	57	58	66	63	N. W.	1	·500	Breezy, heavy showers, occasional sun.
11 Sunday, . . .	29·650	60	29·567	61	51	49	54	57	62	60	S. W	2	·090	Breezy, light showers, occasional sun.
12 Monday, . . .	30·050	60	29·965	60	48	46	54	56	61	59	N. W.	6	. .	Fine, breezy, bright sunshine.
13 Tuesday, . .	30·250	63	29·160	64	47	45	55	57	65	63	N. W.	6	. .	Do.
14 Wednesday, .	30·280	66	30·179	67	44	42	55	58	68	65	N. W.	6	. .	Do.
15 Thursday, . .	30·150	61	30·060	62	51	49	56	58	63	61	S. E.	0	·020	Breezy, light showers, changeable.
16 Friday, . . .	29·900	62	29·812	63	54	52	57	59	65	62	S. E.	0	·900	Cloudy, heavy rain, changeable.
17 Saturday, . .	30·000	66	29·899	65	51	49	58	59	66	64	S. E.	2	. .	Breezy, cloudy, occasional sun.
18 Sunday, . . .	30·150	68	30·044	69	54	52	60	61	71	68	N. E.	6	·030	Fine, breezy, bright sun, light showers.
19 Monday, . . .	30·180	70	30·069	70	56	54	61	62	72	69	N. E.	7	. .	Fine, breezy, bright sunshine.
20 Tuesday, . . .	30·050	69	29·944	69	54	52	60	62	70	67	N. E.	7	. .	Do.
21 Wednesday, .	30·000	70	29·889	71	59	57	62	63	72	69	S. E.	7	. .	Do.
22 Thursday, . .	30·128	70	30·017	70	58	57	62	64	72	69	N. E.	7	. .	Do.
23 Friday, . . .	30·232	70	30·121	72	53	51	62	63	73	70	S. E.	5	. .	Cloudy, mild, occasional sunshine.
24 Saturday, . .	30·276	67	30·175	68	55	53	61	62	70	67	S. E.	5	. .	Do.
25 Sunday, . . .	30·100	66	29·999	68	58	56	60	62	69	66	S. W.	3	·220	Breezy, heavy showers, occasional sun.
26 Monday, . . .	29·866	63	29·778	63	55	53	59	61	64	62	S. W.	2	·190	Do.
27 Tuesday, . .	30·292	63	30·204	64	50	48	57	59	66	63	N. W.	6	. .	Fine, breezy, bright sunshine.
28 Wednesday, . .	30·200	67	30·099	69	48	45	57	60	71	68	N. W.	6	. .	Do.
29 Thursday, . .	29·930	64	29·836	64	57	54	59	61	64	62	S. W.	0	. .	Breezy, cloudy, changeable.
30 Friday, . . .	29·722	62	29·734	62	51	48	57	59	62	60	S. W.	2	·200	Breezy, showery, occasional sun.
31 Saturday, . .	29·786	60	29·703	62	49	46	57	59	64	61	N. W.	4	·180	Do.
												·100	4·700	inches.

SEPTEMBER, 1872.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Sunday,	29·830	53	29·768	53	45	43	54	57	54	52	S. E.	1	·200	Cloudy, wet, changeable.
2 Monday,	29·700	62	29·606	64	51	49	56	58	64	62	S. E.	1	·340	Do.
3 Tuesday,	29·528	62	29·434	63	55	53	57	59	65	63	S. E.	0	. .	Cloudy, mild, changeable.
4 Wednesday,	29·450	61	29·368	60	58	56	57	59	61	59	S. E.	0	·100	Cloudy, showery, with thunder, lightning.
5 Thursday,	29·618	66	29·519	66	57	55	57	60	66	63	S. W.	5	. .	Breezy, changeable, occasional sunshine.
6 Friday	29·572	63	29·473	66	51	49	56	58	67	64	S. W.	2	·140	Breezy, showery, occasional sunshine.
7 Saturday,	29·832	59	29·754	59	54	51	56	58	59	57	S. W.	1	·070	Do.
8 Sunday,	29·940	62	29·852	64	45	43	55	57	64	61	S. W.	6	. .	Fine, breezy, bright sun.
9 Monday,	29·682	59	29·604	58	52	50	56	58	58	56	S. W.	0	·400	Breezy, wet, changeable.
10 Tuesday,	29·824	61	29·741	62	50	48	57	57	62	60	S. W.	4	·170	Breezy, showery, occasional sun.
11 Wednesday,	29·894	68	29·790	68	59	57	58	59	69	66	S. W.	0	·100	Breezy, showery, cloudy.
12 Thursday,	30·050	69	29·944	69	62	60	60	61	69	66	S. W.	0	. .	Breezy, cloudy, changeable.
13 Friday,	30·240	71	30·129	72	63	61	62	63	73	69	S. W.	4	. .	Fine, breezy, bright sun.
14 Saturday,	30·170	61	30·085	61	59	57	60	62	61	59	S. W.	0	·140	Cloudy, showery, changeable.
15 Sunday,	30·100	62	30·010	62	56	54	60	61	63	60	S. W.	0	·150	Do.
16 Monday,	29·980	60	29·876	61	50	48	57	59	61	59	S. W.	0	. .	Breezy, cloudy, changeable.
17 Tuesday,	29·800	60	29·717	61	49	47	56	57	62	60	S. W.	2	·040	Breezy, showery, occasional sun.
18 Wednesday,	29·472	57	29·410	57	46	44	54	57	58	56	S. W.	2	·100	Do.
19 Thursday,	29·700	54	29·633	54	44	43	52	55	55	53	N. W.	5	·060	Breezy, bright sun, showery.
20 Friday,	29·900	53	29·838	55	38	36	49	53	56	54	N. W.	5	·030	Do.
21 Saturday,	29·822	51	29·746	51	38	36	49	52	51	49	N. W.	4	·020	Do.
22 Sunday,	29·972	52	29·010	52	36	34	47	50	53	51	N. W.	4	·040	Breezy, bright sunshine, changeable.
23 Monday,	29·650	56	29·579	57	40	38	48	51	57	55	S. W.	2	·080	Breezy, showery, occasional sun.
24 Tuesday,	29·550	47	29·504	50	35	33	47	50	51	49	S. W.	1	·150	Do.
25 Wednesday,	29·750	51	29·693	53	41	39	48	50	54	52	S. W.	2	·120	Do.
26 Thursday,	30·000	51	29·942	58	36	34	46	49	54	52	N. W.	5	. .	Fine, breezy, bright sunshine.
27 Friday,	29·450	57	29·379	57	48	47	49	50	57	55	S. W.	0	·400	Breezy, wet, changeable.
28 Saturday,	29·442	55	29·376	56	47	45	49	51	56	54	S. W.	2	·110	Breezy, showery, occasional sun.
29 Sunday,	29·700	56	29·627	57	48	46	49	51	58	56	S. W.	4	. .	Fine, breezy, bright sun.
30 Monday,	29·788	54	29·721	56	43	40	49	51	58	56	S. W.	3	. .	Breezy, cloudy, occasional sun.
												65	2·880	Inches.

No. XLII.—Vol. VI.] [Price 2s.

THE JOURNAL

OF THE

ROYAL DUBLIN SOCIETY.

CONTENTS:

	PAGE.
1. Dr. Reynolds on Superphosphates,	359
2. Mr. Hardman on the present state of Coal Mining,	366
3. Dr. Moore on the Successful Establishment of Loranthus Europeus on Oak Trees,	383
4. Professor Tanner on Comparative Trials of Artificial Fertilizers,	387
5. Mr. Andrews on the Sea-Coast Fisheries of Ireland,	397
6. Dr. Macalister on the Anthropoid Apes,	418
7. Return of Donations to the Royal Dublin Society,	427
8. Intelligence:—	
School of Art,	438
Spring Cattle Show, 1873,	456
Evening Meetings,	457
Tables of Mean Temperature, Direction of Wind, and Rainfall,	463
Appendix—Meteorological Journal from 1st October, 1872, to 31st Dec., 1873,	i

DUBLIN:

HODGES, FOSTER, AND CO., 104, GRAFTON-STREET,

BOOKSELLERS TO THE ROYAL DUBLIN SOCIETY.

LONDON: SIMPKIN, MARSHALL, AND CO. EDINBURGH: JOHN MENZIES AND CO.

1874.

The Society

Royal Dublin Society.

FOUNDED 1731. INCORPORATED 1749.

The Society consists of Members, who, on being proposed and seconded, are elected at the next Meeting by Ballot, previously to which the Fees, as follows, must be lodged with the Treasurer:—

Life Membership,	£21	0	0
Annual Membership (with £3 3s. Entrance Fee),	2	2	0

Annual Subscriptions due on 1st January. Persons in arrear on the 1st April cease to be Members.

Annual Members may at any time become Life Members upon payment of £15 15*s*., £10 10*s*., or £5 5*s*., according to standing.

I.—Meetings of the Society and the Council.

1. *Stated and Ordinary Meetings.*

The Society meets at 3 o'Clock P. M., pursuant to the Charter, on the second Thursday in November, and the First Thursday in March and June.

The Council meets during the Session at Three o'Clock on every Thursday not occupied by the Meetings of the Society.

2. *Evening Scientific Meetings.*

Meetings of the Society, for the reading and discussion of Papers on Scientific subjects, are held on the third Monday in each Month during the Session.

Persons desirous to read Communications must submit their Papers to the Committee a week, at least, previously, for examination and approval.

The Copyright of all Papers read becomes the property of the Society; and such as are considered suitable for the purpose will be published in the Journal of the Society.

Except under special circumstances, no person can be permitted to occupy the Meeting in reading a Paper for a longer period than half-an-hour; and the Society will not be held responsible for any opinions advocated in the communications read.

Each Subscriber of 5*s*. to the Refreshment Fund is entitled to Tickets, to admit Visitors, at 6*d*. each; or to twelve for 5*s*., available for any of the ordinary Meetings throughout the Session.

The Standing Committees.

Six Standing Committees are annually elected, as follows:—1. Agriculture; 2. Botany; 3. Fine Arts; 4. Library; 5. Natural History; 6. Practical Science.

[*For continuation, see page 3 of Cover.*

THE JOURNAL

OF THE

ROYAL DUBLIN SOCIETY.

XXVI.—*On Superphosphates—their Adulterations and Valuation.*

By J. Emerson Reynolds, M. R. C. P., Professor of Analytical Chemistry to the Royal Dublin Society, Keeper of the Minerals, &c.

[Read Monday, November 18, 1872.]

However much we may lament the existence of fraudulent dealing on moral grounds, it appears to me a study of high interest to follow this "trail of the serpent" amongst the things around us, to measure its effect upon the general welfare, and to devise means for its detection and suppression. In order to pursue such an inquiry with advantage, we must select a particular class of fraud; and the class to which I invite your attention this evening is that so frequently the subject of investigation by the analytical chemist—namely, the adulteration of articles of commerce. But I may further restrict the few remarks I have to make to a special order of adulteration which materially affects the agricultural community. The frauds to which I refer are those connected with artificial manures; but more particularly with the very important group of fertilizers included under the term "Superphosphates."

We have had the opportunity of watching, for many years past, the steady development of a great trade in artificial manures and the corresponding outcrop of devices by which dishonest traders have imposed on the farmer—with the result of diminishing his produce, and thus indirectly affecting the community at large.

To the agriculturist as to the manufacturer, the value of a "Superphosphate" is directly proportional to the amount of "Soluble Phosphate," "Insoluble Phosphate," "Alkaline Salt," and "Ammonia," either ready formed or latent, that it contains. A very few seasons since, it was by no means uncommon to meet with "Superphosphate" sold at a good price, and containing *no* Soluble Phosphate and but a small proportion of other valuable substances—clay, road-stuff, gypsum, or waste products of various kinds from chemical works being used up in preparing the very feeble fertilizer. The same materials, of little value, were still more frequently used for diluting the genuine manure, and this practice is far from being uncommon at present.

I need not stop to consider in any detail the effect of this dishonest dealing on the farmer—his wasted means, unrequited labour, and consequent disappointment. To do more than refer to these misfortunes, and to the consequent national loss would be to repeat an oft told tale.

The adulterators of "Superphosphate," bold though they were at first, soon received a check, for agricultural societies employed chemists in the detection of the frauds, with the result of obliging the greater cheats either to rest satisfied with the profits derivable from small adulterations, or to transfer their attentions to guanos or other substances that could be rather more safely tampered with.

Speaking now from my experience as chemist to this Society, I am justified in stating that gross adulterations of Superphosphate are now rarely practised—probably not because the dishonest dealer has lost the desire for large profits: but for the sufficient reason, that the risk of detection is now too great. He has, therefore, fallen back upon the more subtle plan of mixing with a manure a quantity of some nearly worthless substance that it already contains as a natural constituent. The addition of gypsum to a Superphosphate is an adulteration of this kind, for all these manures contain gypsum as a necessary product of the action of oil of vitriol on phosphate of lime—whether the latter is derived from bones, coprolites, or other similar mineral phosphates. When this addition of extraneous gypsum falls within certain limits it is difficult to prove the adulteration, as manures of the same kind and honestly prepared are known to vary somewhat in composition. Now, under these circumstances it will be asked, what control have we over this more refined kind of adulteration? The answer to this ought to be that a complete system of chemical valuation is employed by means of which any sensible reduction from a common standard is at once detected. But such an answer cannot as yet be truly given. Manures of the class referred to certainly have money values attached to them after analysis made on behalf of the purchaser or the vendor; but a very few examples will suffice to show how little importance is to be attached to such estimates. Thus we find a manure selling at £6 per ton valued at £8 15*s.*; another whose selling price is £6 5*s.*, valued at £9 8*s.*, others sold at £6 10*s.*, £6 6*s.*, and £7—appraised by one chemist at £7, £8, and £8 10*s.* respectively, and by another at £6 18*s.*, £7, and £7 2*s.*, though the two sets of analyses fairly agreed and were made about the same time. These discrepancies are accounted for to a considerable extent by supposing that one chemist attaches much more importance to certain constituents than another does—one values in the interest of the vendor, the other in that of the purchaser, and all the estimates are wide of the truth. Valuation of this kind, however, is probably useful for purposes of comparison when a particular set of samples are under examination; but for general use the system is simply misleading, and unable in its present guise to afford the information we require in dealing with doubtful cases. Hence, about three years ago, I ceased to assign money values to manures unless where specially requested to do so on receiving a sample for analysis. I understand that Dr. Vöelcker, the distinguished chemist to the Royal Agricultural

Society of England, now declines to attach a money value to a sample of manure under any circumstances.

Nevertheless, a satisfactory system of valuation ought to be constructed, as it is capable of rendering great service. I venture to think that no insuperable difficulties lie in the way, and my chief object, this evening, is to lay before you the details of a plan for estimating relative values of "Superphosphates" which appears to be fair alike to vendor and purchaser. If I succeed in proving to you, in the first place, that we may precisely fix the relative commercial values of the constituents of a "Superphosphate;" and secondly, that we can take a standard to which reference can be made, it will be easy to complete the work and to show how the data may be utilized.

In dealing with the first branch of this question it is well to explain at the outset the method of valuation at present employed.

A certain money value per ton is assigned to each important constituent of a manure; thus Ammonia at £95 per ton; Soluble Phosphate, £30; Insoluble Phosphate, £11; Alkaline Salts, £3; Organic matter, £1; Gypsum, £1. A sample is analysed, and the per centage statement is held to indicate the composition of 100 tons. The number of tons of each body present is then multiplied by its price per ton, the various amounts then added together, and the estimated value of 100 tons obtained.

Having indicated the system at present in use, we now have to fix the relative values of the important constituents by consulting dealers in the several raw materials as to their cost; and manufacturers of manure as to the expense attending the necessary treatment, excluding charges which do not affect the *relative* values. I have to acknowledge here the promptitude and courtesy with which my inquiries have almost invariably been met by many merchants, agents, and manufacturers. Without giving details of outlay, with which I have been kindly furnished in confidence from several quarters, I may now state the table of equivalent numbers that I have been thus enabled to construct—and these represent the mean of the several values at the present time. We may eliminate the "organic matter" that appears in an analysis from our list, since I give the equivalent of its "latent ammonia;" and "gypsum" also, because the equivalent of "biphosphate" includes that of the corresponding sulphuric acid of the "gypsum." The table is therefore limited to the following six bodies, and these are referred to ammonia as unity.

Ammonia ready formed, . . .	1·0
Ammonia latent, ...	2·2
Biphosphate, ...	4·0
Bone Phosphate, ...	8·0
Mineral Phosphate, ...	13·0
*Alkaline Salts, ...	22·5

* The value of "Alkaline Salts" varies chiefly according to the proportion of potash salts present. In my opinion it would be unfair to the manufacturer to assign to them a lower relative value than that given in the table.

This table somewhat resembles that of equivalents of the elements used in chemistry—that is to say, the numbers are strictly proportional to one another, and indicate the replacing values of the different bodies to the manufacturer.

The table also fairly represents the average relative values of the several substances to the farmer. Now, though the *average* agricultural values are not subject to fluctuation, the numbers in the above table require slight corrections to be applied to them from time to time, owing to variations in the *relative* cost of materials. Where any change of the kind is necessary, the correction should be applied prior to the commencement of each season, in order that all manures sold during a particular period should be fairly judged in the same way.

We have therefore substituted for money values a series of proportional numbers that can be used with great advantage, and have thus made the first step toward the solution of the proposed problem. As an example of the mode of using the figures, I may give the following analysis of a fair mineral superphosphate offered for sale at £6 per ton.

100 parts contained:—

Water, ...	12·85			
*Organic and volatile matter,	22·65			
Biphosphate, ...	16·99	÷ 4·0	=	424·2
Neutral phosphate (mineral)	12·25	÷ 13·0	=	94·2
Alkaline salts, ...	1·50	÷ 22·5	=	6·6
Sulphate of lime, ...	29·06			
Sand, &c.	4·70			
	100·00			
*Ammonia, ...	·40	÷ 1·0	=	40·0
				565·0

In the above analysis, not made by me, the Ammonia is not stated to be ready formed, nor is it shown to be "latent." Under these circumstances, I consider it fair to the manufacturers to assume that it is immediately available, though it is highly improbable that all the nitrogen exists in the manure as ammonia. The percentages of the four valuable constituents have been divided by the corresponding equivalent numbers, and in the products the decimal points shifted two places to the right, in order to get convenient terms. The numbers have then been added together, and the product I call 565 degrees on the R. D. S. Scale of relative value. Instead of shifting the decimal points in the products, we may obviously do away with the decimal points in the analytical statement, and take the numbers given to represent parts in 10,000.

I now give a number of analyses of mineral and bone Superphosphate made by different chemists. The samples are numbered, and the manufacturers' names suppressed, for obvious reasons. The price to the farmer is given in each case, and the *agents'* marked on the plan just described.

"SUPERPHOSPHATES."

	Mineral.					Bone.					
Selling Price, per Ton.	£6.	£6 10*s.*	£6 10*s.*	£6 10*s.*	£6 10*s.*	£8.	£8.	£8.	£6 15*s.*	£8.	£8.
Degrees on Royal Dublin Society's Scale.	595°.	680°.	615°.	520°.	509°.	883°.	587°.	600°.	573°.	655°	811°.
Water, ...	16·10	15·97	17·50	28·80	19·75	—	18·70	14·40	16·60	14·87	8·20
Organic Matter, &c., .	17·52	14·58	12·25	15·70	16·95	37·89	16·59	25·25	28 25	28·98	21·58
Biphosphate, . . .	15·92	20·55	19·52	14·36	16·15	11·80	14·80	11·05	12·72	17·40	19.28
Neutral Phosphate, .	10·00	13·10	14·90	14·33	6·80	18·00	2·60	4·55	8·55	8 40	16·25
Alkaline Salts, . . .	4·55	·80	·46	2·45	·52	3·00	trace.	3·44	1·95	1·05	1·45
Sulphate of Lime, . .	32·89	30·80	29·42	26·11	35·31	27·71	41 41	36·16	27·75	31·10	27·47
Insoluble Matter, . .	3·02	4·25	5·95	8·75	4·52	2·60	6·40	5·15	4·18	3·70	5·82
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Ammonia, ...	1·00	·13	·12	·12	·30	3·62	1·49	2·58	1·40	1·10	1·20
Number of Sample, . .	2	3	4	5	6	7	8	9	10	11	12

Having pointed out the manner in which the table of equivalents can be used for the purpose of obtaining an accurate expression for the relative total values, we may discuss the data, and endeavour to deduce standards for the two classes of Superphosphates.

Mineral Superphosphates. With the exception of Nos. 1 and 2 all those manures whose analyses are given, were sold at £6 10*s.* per ton to the farmer. By adding in each case one-thirteenth to the number found for Nos. 1 and 2 on the Royal Dublin Society's Scale, we can consider them as if sold for £6 10*s.* per ton each—and therefore compare their numbers with those given for the remaining samples. In the following table these corrections have been made.

Number.	Sold to farmer.	Degree on R. D. S. scale.
1.	£6 10*s.*	612°.
2.	6 10*s.*	644°.
3.	6 10*s.*	630°.
4.	6 10*s.*	615°.
5.	6 10*s.*	520°.
6.	6 10*s.*	509°.

Dismissing Nos. 5 and 6 as being of inferior quality, we have four of these Superphosphates, made by different manufacturers, sold at the same price, and approaching closely to each other in the number of degrees reached on the Royal Dublin Society scale. They are undoubtedly useful fertilizers, and their mean number agrees with the mean afforded by my own analyses of corresponding samples. We are therefore in a position to fix our standard of value for a mineral Superphosphate as follows:—*Samples marking* 620° *on the Royal Dublin Society scale above described, should not cost the farmer more than* £6 10*s. per ton.*

From the foregoing we at once deduce the simple and convenient statement, that a manure marking 600° R. D. S. degrees is worth just *six guineas* per ton.

A single example of the use that I make of this "Royal Dublin Society Standard Mineral Superphosphate" will suffice. Let us suppose that a farmer purchases a sample of Mineral Superphosphate at £6 10*s.* per ton, and that on the discussion of its analysis it affords the same number as No. 6, namely, 509° on the R. D. S. scale, we at once report the manure to be value for only £5 6*s.* 8*d.*

The money value obtained on the old plan and actually attached to No. 6 by the analyst was £6 7*s.* per ton. The latter estimation would, therefore, indicate to the purchaser at £6 10*s.* that he obtained fair value for his money, though really paying about £1 per ton too much. My system at once detects and measures this serious reduction in value.

Bone Superphosphates.—In these cases the equivalent number "8" of a Bone Phosphate (see table) has been used for dividing the Insoluble Phosphate; the number "13" being used for the same purpose in dis-

cussing the analyses of the Mineral Superphosphates. The superiority of undissolved Bone Phosphate over the Mineral Phosphate in the same condition being thus fully and fairly recognised, the degrees on the R. D. S. scale afforded by the Bone Manure of course have the same meaning as when deduced from the analysis of a Mineral Superphosphate. Our standard Mineral Superphosphate, therefore, measures the value of a Bone Manure. If, then, the former is only value for £6 10*s.* per ton, when it marks 620 degrees on the R. D. S. scale, the Bone Manure is only value for £8 per ton when it reaches 763 degrees on the same scale.

Having deduced our standard from the previous inquiry, we may now ascertain how far the result is confirmed on the discussion of the above given analyses of Bone Superphosphates.

We first have to raise the equivalent of No. 10 from 573 degrees to 679, being in the ratio of £6 15*s.* to £8, and then tabulate the numbers as before, thus:—

Number.	Sold to Farmer.	Degree on R. D. S. scale.
7, ...	£8 0 0	883°.
8, ...	do.	537°.
9, ...	do.	600°.
10, ...	do.	679°.
11, ...	do.	655°.
12, ...	do.	811°.

Nos. 7 and 12 are derived from vendor's analyses, the rest from those of purchasers. No. 8 is so obviously a very inferior manure that we may dismiss it from consideration. Then, taking the average of the remaining five samples we get as the mean result on the R. D. S. scale 745 degrees. We are therefore fully justified in adopting as a fair standard that which we have deduced from other considerations, namely, 763 *degrees on the Royal Dublin Society scale for a sample of Bone Superphosphate costing the farmer not more than* £8 *per ton.*

Having, I hope, shown that the existing system of valuation of Superphosphates may be replaced with advantage by another capable of yielding results of higher accuracy and practical value, and having fixed certain standards, by reference to which these artificial manures can be adjudicated upon with fairness alike to the vendor and the farmer; I ought to give notice that all Superphosphates sent to the Royal Dublin Society for analysis must now be valued on the above plan.

In concluding this Paper I may venture to express the opinion that much public advantage would accrue if the Royal Dublin Society offered some inducement to dealers in Superphosphates to compete, on the understanding that the best sample offered at a given price to the farmer, should be used as the standard for reference during the season immediately following the competition. However, until some such plan is adopted, I venture to think we may fairly rest content with the standards I have now endeavoured to fix.

XXVII.—On the Present State of Coal Mining in the County of Tyrone. By Edward T. Hardman, F. R. G. S. I., Associate, Royal College of Science, Dublin; of the Geological Survey of Ireland.

[Read Monday, November 18, 1872.]

In the County Tyrone, there are two small coal-fields, the larger of which possesses some interest, from a commercial, as well as from a geological point of view.

Of this coal-field, records are in existence which relate to workings carried on about a hundred years ago, while tradition carries us back to a much earlier period of mining enterprise there; but for at least a century, the coal has been continuously wrought, innumerable pits having been opened and a large quantity of fuel removed, without, however, benefiting to any appreciable extent any person concerned, save perhaps the owners of the royalties.

As the coal-field, although small in superficial extent, contains a great number of workable, and some valuable seams at a comparatively trifling depth, and many of them capable of being worked together by one shaft, while the total amount of available coal exceeds that in any other Irish field, except that of Leinster, it may be worth inquiring into the reasons which have hitherto prevented the workings being remunerative, although high prices are readily obtainable; fuel of all kinds being exceedingly dear on account of the rates charged for the carriage of coal inland from seaports, and an additional demand existing in consequence of numerous mills and factories being in operation all through the district.

It is not intended—nor indeed is it necessary—in this paper to enter at any length into geological details of the coal-field.* But I shall give a short description of its resources, such as the remarks I am about to make on the manner of working require.

The coal-bearing country—uncovered by other strata—extends from near Dungannon to beyond Coalisland in a north-easterly direction, and is about 3¾ miles long. The greatest breadth is 2¼ miles, from a large boundary fault on the west to the edge of the New Red Sandstone formation on the east. As the shape of the exposed coal-measures forms a triangle, the area is about 4½ square miles, or 3000 acres, but they continue under the Triassic beds for an unknown distance, and have been worked beneath them in several places: as yet however to a very trifling degree.

The lowest seams of coal are found within a mile and a half north

---

* The geology of this coal-field has been already described, more or less fully, by several observers; Sir Richard Griffith's valuable report—"Geological and Mining Survey of Tyrone and Antrim"—is so well known as hardly to need a reference here; while in Gen. Portlock's "Geological Report," &c.; and Sir R. Kane's "Industrial Resources of Ireland," much information on this subject is to be obtained.

of Dungannon.* First comes the "Monkey" or "Lower coal." It is about two feet thick, and has been worked profitably at the outcrop. None of it is to be seen now, but the miners report well of it. Over this are from ten to thirty yards of strata, and then, the "Drumglass" or "Main coal." This is a very good seam. Its average thickness is five feet, although it has sometimes reached eleven feet. It contains a band of shale or "clearing," of variable dimensions, usually increasing, with the thickness of the seam, from one to six feet, and dividing the coal into the "top" and "bottom" coals. The former is a very good pure coal, comes out in large blocks, and is better than Scotch, but inferior to the best English coal. It contains iron pyrites or "sulphur," but burns slowly and gives out a great heat, producing a reddish ash, but not in large quantity. It answers well for domestic purposes. The bottom coal is rather slaty and contains much ash. Both mixed answer admirably for steam coal. This is a free burning coal. The slack cakes well. At present the prices at bank are 25*s.* per ton for picked coal, 18*s.* for second quality, and 16*s.* for slack.

About forty years ago an extensive working was made on this coal towards the centre of the line of crop, where the quality is said to be best. The seam here was 4 feet 10½ inches, viz.:—

	Ft.	In.
Top coal . .	1	10½
"Clearing," .	1	0
Bottom coal, .	2	0
	4	10½

A pit 120 yards was put down, and a considerable amount of coal removed. However, a series of accidents, combined with negligence on the part of the miners, led to its being drowned out; and no attempt has since been made on that part of the "Main coal." A large quantity still remains and would probably repay a well-managed enterprise. There are now but one or two small pits on this seam, and so small and in such positions as to be of little value.†

Nearly two miles of almost unproved ground lie between this outcrop and that of the next workable seam. This is a very valuable one. It is called the Creenagh coal, and is four feet six inches thick, including about twelve or fourteen inches of Cannel in the centre. This has been proved in various gas works to be equal to Lesmahagow, and much superior to Wigan, Cannel.‡ It now brings at bank from

* Their outcrops can be traced from the boundary fault to the New Red Sandstone, a distance of two and a half miles.

† The position, and extent to the dip—so far as can be yet made out—of the "Main" and "Monkey" coals is shown in the accompanying sections.

From the pit just referred to more than 190,000 tons were *sold* in ten years.

130 yards of strata have been "proved" over the "main coal."

‡ According to a report by Dr. Wallace, F. R. S. E., &c., Gas Examiner to the City of Glasgow, one ton of the Creenagh coal yields 11,500 to 12,000 cubic feet of gas, with an illuminating power of 34 standard sperm candles.

45*s.* to 50*s.* per ton! the soft top and bottom coals, picked 26*s.*, and slack 18*s.*, while a kind of bituminous shale called "cracker," which lies between the Cannel and soft coals, helps in the engine firing; the cost of raising a ton of this seam is about 7*s.* 6*d.*; that is, for each ton of Cannel about 27*s.* There is only one colliery now working here, and it is situated near the outcrop. It appears to be fairly successful, so far. This seam has as yet been very little meddled with. The dip is towards the east under the Triassic rocks. There can be little doubt of the success of a deep pit sunk through those beds, and I believe that this coal, if not others, would be found at a workable depth even under the Tertiary clays still further to the eastward.

The Creenagh coal crops out across the Torrent River, nearly a mile south of Coalisland. If we follow the course of the river upwards for a little distance from this outcrop, and then strike over the country for a mile and a half, and through the village, we shall in that short distance traverse the edges of no fewer than eight coals, of a yard and upwards in thickness.* In that number there are four "yard" coals; two "5-feet," a "6-foot" with twenty inches of Cannel, and a "9-foot;" while interspersed amongst these are several small "Monkey coals" varying from ten inches to two feet thick, some of which have been worked, and found to be of good quality. All these seams lie in about 200 yards of strata; and it has been remarked by Sir Richard Griffith, Sir Robert Kane, and other authorities, that it is a rare, if not unknown circumstance, to find such a thickness of coal in such a trifling depth. These coals are all solid, with the exception of a few inches of "clunch" in some of them. They are often slaty, and on an average are hardly equal to the "Drumglass" coal, although some of them are better. Nearly all contain more or less sulphur. The measures here are much softer than those already spoken of; and in the upper beds, shales, fireclays, and slate, predominate.

There are ten known workable coals in the Dungannon coal-field, counting none worth notice that are less than three feet thick. They are usually called after the townlands in which they were first wrought. Here is a list of them in descending order† :—

Coalisland, or Upper-series.	Annagher coal, . .	9ft.
	Strata, 13 to 18 yds.	
	Bone coal, ...	3ft.
	Strata, 9 to 13 yds.	
	Shining seam,. . .	2ft. 10in. to 3ft.
	Strata 24 to 26 yds.	
	Brackaville coal, . .	5ft.
	Strata, 16 to 32 yds.	

* In the entire coal-field *eighteen distinct seams* have been wrought on, at one time and another, comprising coals of from ten inches to nine feet in thickness; but in this Paper only those of a yard and upwards will be considered as of economic value.

† See Section No. 1.

Coalisland, or Upper-series.	Gortnaskea coal, . .	6ft.
	With twenty inches Cannel.*	
	Strata, 25 to 35 yds.	
	Beltiboy coal, . . .	3ft. to 3ft. 6in.
	Strata (with 4 coals), 40 to 60 yds.	
	Derry coal, . . .	3ft. to 5ft.
	Strata (with 2 coals), 50 yds.	
	Yard coal, ...	2ft. 10in. to 3ft.
	Strata, 80 yds. proved (with 2 small coals).	
Relative position uncertain.	*Unknown ground.*	
	Strata, 30 yds.	
	Creenagh coal, . .	4ft. 6in.
	Unknown ground.	
Drumglass, or Lower-series.	Strata, 130 yds.	
	Main coal, ...	4ft. 10in. to 11ft.
	Strata, 10 to 30 yds.	
	Monkey coal, . . .	1ft. 10in. to 2ft.

These are all bituminous or flaming coals. They have been wrought along the outcrop in a vast number of shallow pits, which have rarely exceeded thirty yards in depth. About a dozen have reached sixty or seventy yards, and five have actually exceeded 100.

The quantity of coal removed up to this has not been large when compared with the whole amount, and a considerable deposit still awaits the enterprising miner —but it has been taken away to a sufficient depth to satisfy local tastes. At Coalisland alone about one million tons have been taken out or spoiled, and, on a moderate estimate, there are at least twelve millions untouched, without taking into consideration the small coals under a yard in thickness; or the Creenagh seam which has as yet been wrought only in one small corner of its outcrop, and is entirely unproved elsewhere. It may be, and probably is, of some extent.

Of the Drumglass coal, lying near Dungannon, about one and a half million tons have been removed, and perhaps four and a half millions lie in that part of which anything is known. However, there is a wide strip of country between the latter and the first coal of the Coalisland series, of which nothing whatever is recorded, and which can hardly be said to have been explored at all. This debateable land comprises an area of nearly 1500 acres, and there is no reason why it might not contain productive seams of coal. Indeed, a few thin seams have

* From specimens picked up at the old workings this appears to have been a fine Cannel. It was got out in such large blocks that the ordinary barrels would not contain them. They were, therefore, slung up in ropes.

been discovered close to the surface in the course of some imperfect and timorous trials, but nothing like a fair examination has ever been made, and the existence, everywhere, of a thick coating of drift, prevents the possibility of making out anything about it without having recourse to a good deep borehole.

In the above estimate, only the amount of coal lying in the uncovered coal-measures have been considered. This area is about 3000 acres, and the quantity of coal untouched there, about sixteen millions of tons. But under the New Red strata it is possible that the coals lie within a workable depth over an area of, at least, 2500 acres, which would give nearly sixteen millions more.* So that the whole available resources of this district may be put down as at least thirty millions. Professor Hull estimates the available tonnage at thirty-two millions.† It appears, therefore, that the Dungannon coal-field is second in resources amongst Irish ones.‡ This is very remarkable when the small comparative area of it is remembered.

In the section (No. 2), I have endeavoured to show the general sequence of the coal seams from end to end of the field; to show the relative extent of proved and unproved ground, and to compare the depth to which the coal has been worked with the ground which is yet untouched. The diagonally-lined band represents the depths to which the workings have been carried, that is, on an average about 200 feet, and indeed seldom so much. It will be seen that about 400 feet more would pierce through all the coals of the upper series where they come together towards the north-east, and that further back towards the outcrop pits of moderate depth would command two or three good coals to a fair extent.

Those parts of the section shaded, and with black lines representing the coals, are the portions in which the respective coals have been proved, either directly or indirectly, to exist, ***but in which no workings have yet been made.*** The comparison between the portion wrought out and that remaining is instructive. The coals shown are the same as those in section No. 1, with the exception of the Creenagh coal, which is not cut across by the line of section.

The unshaded portion shows the unproved ground already referred to, and which constitutes a very considerable moiety of the coal-field. It is, in fact, nearly as long as that which contains the eight coals of the upper series, and, for aught that is known, might contain as many, or perhaps the same ones repeated. The few trials that were made here merely proved the ground to be coal-measures with coal-beds, and were too imperfect to show whether the latter are new, or some of those already known. One or two proper trials might show the resources of the coal-field to be much greater than is as yet supposed.

---

* Or if we cared to go down so far as English miners, probably a much larger quantity.

† Report of Royal Coal Commission (1871), Vol. i., p. 78.

‡ See Estimates of Irish Coal Fields, *loc. cit.*

There is a most extraordinary apathy, however, existing in Ireland with regard to such matters, or rather, a dislike to look for coal in the right place, coupled with an astonishing eagerness to make searches in impossible localities.

From some remarks dropped lately in the Board-room of the North Dublin Union on the subject of the Dungannon coal, it would appear that there is an idea floating abroad that Irish coals are never thick enough to be worked profitably; but this is quite erroneous with regard to all, and especially so respecting the Dungannon coal-field, possessing, as it does, ten coals, many of which are much thicker than seams often worked with advantage at a great depth in England.

Some four miles north of Coalisland is a small strip of coal measures, in which three coals have been proved. Two of these are very good, one being nine and the other three feet thick. These having been much wrought on, and the exposed coal measures being but of trifling dimensions—(about, perhaps, two hundred and fifty acres),—a very limited supply can be reckoned on from this—the Annaghone—coal-field. The coal-beds, no doubt, here also extend under the New Red Sandstone, which is seen on the south and east, and the Permian on the north-east; but until they shall be proved no opinion can be given as to their value.*

It is remarkable that the coal of the Dungannon district is characterized by an almost entire absence of fire-damp, or, as it is locally called, "fire." It has been only known to occur in two pits, one of which was very shallow, and the other, although the deepest in the field, was only thirty yards in coal-measures. The presence of the gas was marked in one instance by a fatal accident, and in other cases by burnings, more or less severe. Perhaps the numerous faults which cut through the strata permit of its escape, and give a kind of natural ventilation; but at any rate the miners have the great advantage of being able to work with a naked light, and of knowing little or no risk. Choke-damp is abundant, but as all the pits are very small it is easy to procure good ventilation. In the Annaghone coal-field fire-damp was very troublesome, and it was necessary to use safety lamps.

Water, although abundant, is not unusually so, and, with proper machinery, could be easily mastered. The chief annoyances to be met with are faults, which in some parts are very numerous; and among the upper measures a dominance of soft strata, which renders timbering

---

* This field has been untouched for many years; at present a trifling attempt is being made to re-open it; but from its position of little value.

The section proved in Annaghone is as follows:—

Strata, 57 yds.
Main coal, 6ft. to 9ft.
Strata, 25 yds.
Shining seam, 2ft. to 3ft.
Strata, 12 to 25 yds.
Coal, 1ft.

difficult and expensive. However, by a judicious choice of the ground, the former could in a great many cases be avoided, and the latter embarrassment is not so unknown as to be necessarily alarming to the practical miner.

The total cost of working the coal here is sometimes rather high; but then the prices obtained are proportionally large. The former varies from 4*s.* 8*d.* (in small pits) to 6*s.* 6*d.*, or even 7*s.* 6*d.* per ton in some cases. This, I think, includes every thing, both expenses at bank and below, as well as Royalties. At Coalisland, where the coals are solid, the expense, per ton, ought to be less than at Drumglass, where a thick clearing has to be got rid of; yet the difference of strata, and, therefore, in the cost of timbering, probably balances this.

Further on I shall give such a detailed list of working prices as I have been able to obtain,

The price of coals last May ranged from 8*s.* to 15*s.* at the pit's mouth; and a very ordinary coal, if it were just removed from slack, brought 11*s.* or 12*s.* At these rates there was an unfailing demand, and a very much greater quantity than was turned out could be readily disposed of. Even here a fair profit could be made; but on the Creenagh coal the gains were much greater. The cannel selling at from 35*s.* to 40*s.*, and the soft coal at 12*s.* made a total of about 20*s.* per ton, and the working expenses were 6*s.* 6*d.*

Now, although the cost of working has hardly at all increased—for there were no strikes of any consequence—prices have risen enormously: for round coal 20*s.* to 26*s.* is demanded, and for slack from 15*s.* to 18*s.*,* so that the cost of this coal in Dublin would be about 32*s.* equal to that of the best English coal delivered ! This fact illustrates one of the causes of the stagnation of affairs in Tyrone. It is sought to make up for backwardness in exploration, and want of energy, by asking an absurdly high price for the little coal that is got out; the consequence being that outside a circle of a couple of miles from the pit no one will have anything to do with the coal.† Surely with labour so much cheaper in Ireland we should afford to give a not superior commodity at an equal if not a smaller first cost.

The coal-field is extremely well situated as a centre of supply. It is within a reasonable distance of Dungannon, Cookstown, and other flourishing manufacturing towns. An excellent canal connects Coal Island with Lough Neagh, and cheap conveyance is thus provided to Portadown, Antrim, Lurgan, and thence by rail to Belfast and the northern parts of Antrim. Besides, there are many mills and manufactories of various kinds scattered about the country within easy reach—while many others might be created, as it were, by an increase in the facilities for obtaining fuel—so that the sale of all the coal that could

---

* As before mentioned, the Cannel now fetches 45*s.* to 50*s.*

† The largest out-put from any one pit, of late years, has been from 100 to 120 tons per week; and this only continued for a very limited period.

possibly be raised is ensured, if sold at prices which would secure to the adventurer even more than a fair profit.*

When, with all these advantages of a large number of thick and good seams at a small depth; easy rates for raising them compared with the large prices obtainable; no fire damp to contend against; a first-rate market, and a native mining population; we see company after company breaking up in disgust, and the workings of private individuals becoming fewer every year, I think it will be agreed that there must be something radically wrong elsewhere than in the coalfield itself. I hope to be able to show that it lies altogether in the manner of working the pits here. And that if this valuable source of fuel were only properly managed, and wrought as it is deemed profitable to work even thin poor coals in other countries, the result would be very different.

At present Coalisland, instead of being a thriving town, full of life and industry, with such manufactures as the presence of a coalfield might naturally create, is a wretched tumble-down village, in which nothing seems to go on well. It contains three or four mills and tile works, and the ruins of several others, which serve for attestations of former mismanagement.

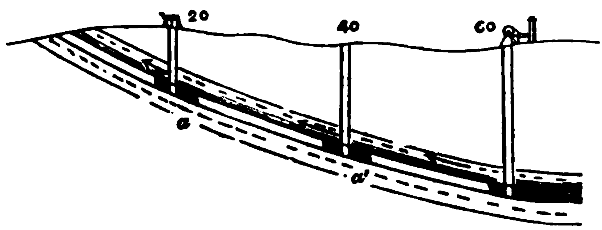
The style of mining is both antique and timid. When I first visited this district there was but one steam-engine working in it; but then there were only four pits open. Since then three other pits, on two of which engines are at work. Of all these, two are only 12 or 14 yards deep, and are worked by "Rolls," or winches; one is 40 yards, and is supplied with a horse-whim; and three, respectively 60, 70, and 90 yards, possess engines.

The great and crying defect here is the system of sinking shallow shafts. There is no faith in the persistence of the coal seam, and there is a great dislike to sink a large sum of money at once on the chance of hitting on a good mine. The ground is therefore felt inch by inch downwards from the outcrop; but this caution does not altogether answer its purpose, the result often being that a considerable sum of money is expended uselessly, or, in fact, absolutely thrown away in this mistaken endeavour to save at the outset.

The plan adopted in laying out a pit is in most cases this. The locality is always selected so as to be at a very little distance from some old workings, in order that there may be no mistake; and a shallow pit is put down, say 20 yards. The winding and drawing apparatus for this consists of a hand-roll and buckets, which are wound by two men. As this pit commands a very short length of upsett, and the machinery would be unable to cope with the disproportionately large quantity of water which is always to be found near the outcrop of strata, if a long level were driven, the mine is soon wrought out. Another, and a deeper shaft, is then sunk to the dip. This may reach

* The chief supply of fuel even for Coalisland itself is imported, for the quantity at present derived from the native workings is too insignificant to make itself felt.

a depth of 40 yards, and is most likely unwatered by a horse-whim. It has hardly a longer term of existence than the other, and, on its conclusion, a third is begun still further to the dip, to the depth of 60 yards. Perhaps a small engine is set up here, but the days of the pit are numbered from the first, for if a trifling roll or "trouble" is met with, the miners lose heart and abandon the work. It is clear that the last would have removed all the coals to the outcrop had it been put down at once, as the following diagram will show:—



The arrows show the direction in which the coal is wrought from the bottom of each pit. *a a'* Portions of coal which in subsequent workings must be left untouched, so as to prevent floodings from the old works.

But not only is the money expended on the former ones literally thrown away, but these now act as reservoirs for a large flow of water, which will come down on the new pit, and make the mining of the coal both difficult and expensive: yet it is almost invariably the rule.

The men have a great dislike to deep pits and long levels. They are not used to them; and they say that these coals are better worked, and more cheaply, by sinking shallow pits on them than by working long levels. The fallacy of this is, of course, apparent when it is considered that in sinking a pit so much useless material must be got out, but that a level driven in coal *pays its way.** However, as the owners depend altogether on the "practical knowledge" and experience of the working colliers, they continue to expend the money one shaft has earned in putting down another.

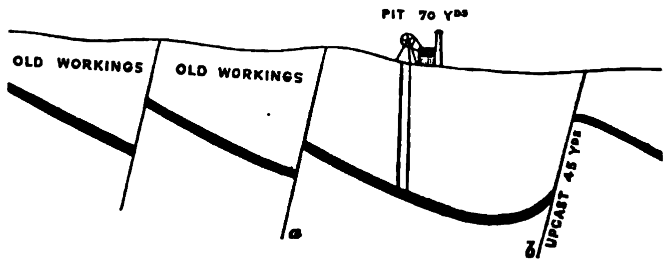
In this manner, and without the slightest improvement or alteration for, probably, the last two hundred years, the coals in the Dungannon district have been attacked, one by one, around the outcrop, and wastefully and unprofitably removed in bands of some 400 feet wide. Save in a very few instances, no pit has ever been used for the working of more than one coal. Although the seams preserve their relative distances with great regularity, and there is almost a perfect

* Moreover, it is only near the outcrop that the sinking of a number of small pits would be cheap. The coal so obtained would, therefore, be of bad quality, and could never be had in any quantity. Besides, with a shallow pit the expenses at bank are as heavy, for a small quantity of coal as would suffice for a much larger output. With an extensive working these are reduced to a minimum.

certainty of finding the next lower seam under any given one, the miners never dream of extending their shaft into lower workings, or even using it to look for the under coal when the upper has been exhausted, or fails. It sometimes happens that the coal which is sought after is bad, or thin, in a particular shaft, while 30 or 40 yards lower down a seam of excellent quality is attainable. But the poor seam is taken, and the other left. Now, in most places in the Coal-island division, a shaft of 100 yards would command at least three very good coals; and by distributing the expenses at bank over a greater quantity of coal, would reduce the mining prices to a very small sum per ton, and materially increase the profits; while by the present system of working with inadequate pits, repeated as explained above, the profits hardly more than balance the expenditure if the venture be continued for any length of time.

As a contrast to this mistaken cautiousness at the commencement, may be mentioned the waste and carelessness permitted in the actual getting of the coal. In the smaller pits it is, instead of being under-cut, merely hewn down roughly. This, to begin with, spoils much of it. Then it is shovelled into a small "hurry" or sledge, which when dragged to the pit's mouth is emptied there with very little regard for the condition of its freight. A second shovelling then places it in the barrel in which it is drawn to the surface, where it arrives mostly as slack, and full of dirt, fireclay, and stone. It is only quite lately that even in the deeper pits tramways have been laid, and any sort of care bestowed on the carriage of the coal, which is all naturally tender, and easily broken up if much knocked about, or allowed to remain soaking in wet, or subject to being trampled on.

Another source of loss and disappointment is the want of knowledge, or rather forethought, displayed in the choice of ground. By a most unlucky coincidence hardly a pit of any size has escaped the proximity of one or more faults, which both deteriorated the quality of the coal, and made it profitless to follow. Thanks to the innumerable attempts at mining that have been made here, from what is called "hoking" at the surface to the more ambitious and usual limit of sixty yards, there are few places where so much information on such matters could be obtained. Yet what might be regarded as a kind of life-sized working plan has been in every case neglected. Some of the most considerable pits are sunk absurdly close to large faults, and can never be expected to make any reasonable return, whilst beside them are abandoned pits, the depths of which are known, and by comparison with each other show at once that there is disturbance. The amount could even be calculated to a nicety. One of the pits referred to was so unfortunate as to get into a perfect nest of faults and old workings. A section through it on the line of dip would be something like this :—



Faults (a) and (b) cut obliquely across the dip so as to shorten the levels, spoil the "upsetts," and prevent "downsetts" or drifts.

It would not be difficult to find many repetitions of this instance; but in every case the evil might have been avoided if a little consideration had been given to the matter, and if the here existing "rule of thumb" method of mining were discontinued. But so long as it is the practice to stick to localities which are honey-combed with the most palpable failures, so long will the money invested continue to disappear, returning neither principal nor interest.

The faults in this coal-field, although numerous, are not always of such magnitude as necessarily, when met with, to cause the pursuit of the working to be relinquished. In most districts they would be cut across, and the levels continued on the other side, when the seam should have been discovered there, if not displaced too much. But here this is seldom done. The direction of the level is altered so as to run alongside of the fault, and as the quality and thickness of the seam is often much deteriorated and reduced there, the miners get tired of following it up, for literally the "game" becomes "not worth the candle;" and a pit that perhaps would pay well is sacrificed for want of a little energy and knowledge.

This dislike to encounter the responsibility and difficulty incumbent on entering new ground operates so strongly in the neighbourhood, that a very great proportion of the mining attempts here are merely confined to "robbing" the remaining pillars in old workings. These are often crushed into slack from so long sustaining the weight of the roof, and are so old that the coal is full of recent crystals of gypsum, calc-spar, and alum, as well as being stained deeply with oxide of iron. The coal, therefore, has a very unfavourable appearance, and so even deters people—who take it to be a fresh average specimen—from being willing to make a proper venture.

The workings differ in many particulars from those of English and Scotch collieries. Partly in consequence of the provisions of the Mines Regulation Acts not yet extending to Ireland, and partly on account of the small extent of the pits, those precautions for the protection of life which are compulsory elsewhere are not in force here.* Thus,

* It must be mentioned, however, that accidents are almost unknown in the district.

each pit has usually only one shaft, which is sometimes divided by a midwall, or "brattice," into two equal portions, one for the haulage of coal, miners, &c., and the other for drawing up water ; for, as pumps have been only tried in one case, the method in general use is to lift it either in barrels or boxes. On the whole, when an engine is employed, this way answers very well for the trifling undertakings here, although there is sometimes a good flow of water; but as the coals are not put out very rapidly—it being preferred to let the demand get ahead of the supply—one small engine of about twenty-five horse-power is quite adequate for all the work.*

In a few pits the coals, on being cut, are placed directly in the "bogie" which is to bring them to the surface. These bogies are small waggons containing from two to four cwt. In most of the pits the barrels are still used, to the great detriment of the coal, and much waste of time. They are the same as used in unwatering, and hold from one to one and a-half cwt.

In many parts of Coalisland it is complained that it is very difficult to keep shafts and levels in order for any length of time, owing to the softness of the measures there. Doubtless, a little more care and expense at first would greatly obviate this. It would be well worth while to put down a strong, and properly tubbed shaft. It is important that the tubbing should be made as tight as possible ; for as the water is taken up in open barrels and boxes, much of it is thrown against the sides : and, finding its way into the soft strata, causes them to swell with great pressure, so as even to crush in the timbers. This precaution is not always taken, and I believe the want of it would be found to be one of the chief reasons for the inconvenience referred to. There are many mistakes made in the securing of shafts, which an experienced man would set right at once.†

The same observations apply to the under-ground passages. In the lower measures the beds are for the most part sufficiently firm to allow of the coal being removed without much expense of timber. The measures here principally consist of sandstone and sandstone slate, with but little soft shale or fireclay.‡ But from the Beltiboy coal upwards

* There is no such practice here as "banking" coal. It is merely turned out as it is wanted, although there is rather a brisk demand. Usually a string of carts may be seen waiting each for its turn ; the man last on the list, after waiting hopelessly, but perseveringly, for hours, often departing coalless, and it becomes, in fact, a matter of favour to obtain a ton of the precious mineral. Thus, an additional expense must be met by the consumer, who, if he lives at any distance, finds that he can procure his fuel cheaper and with less trouble from English pits.

† In fact, even the deepest shafts here have been constructed with a view to temporary use only, and levels the same; the instinct which prevails with regard to shallow workings being carried into practice in all. It is not astonishing, therefore, that frequently the pit has to be given up long before a fair amount of coal has been won.

‡ The timbers used are two uprights or "puncheons," with a "lid" or crosspiece at top, of six-inch trees sawn in half, placed eighteen inches apart from centre to centre. In some cases they must be placed at half that distance.

the shaley beds predominate, and it becomes then hard to keep the roads and levels open for any length of time. Of course, with the shallow and limited pits that are yet in vogue, it would never answer to take any extraordinary means for supporting the roof; but it is a question whether it would not pay, in a large, deep pit even to tunnel at least the main levels. It is certainly only by using the best means and appliances known that mining here will ever be profitable. Any further attempt in the present barbarous and unscientific mode can only lead to disappointment and waste of money. .

Ventilation is in all the pits extremely good, and it is perhaps somewhat due to this that fire-damp is so seldom observed. The good air is probably as much to be ascribed to the insignificant size of the works as to any excellence in the arrangements, which, although rude, present nothing particularly worthy of notice. They answer the purpose for which they are designed admirably. Furnaces are seldom or never used, the natural difference of temperature above and below is permitted to produce the effect.

In working the coals here the "pillar and stall" method is preferred. It is in most cases necessitated by the nature of the ground, as the roof is often very rotten. The pillars are usually six yards square; the roadways and levels six feet wide; the upsetts four or five; but in some the levels are so very narrow that it is difficult to crawl through. The "long wall" system was tried in one pit, but failed, for there was no "rock" with which to build up walls for the keeping up of the mainways. Where it could be managed it would undoubtedly be the best way and the least expensive, for nearly all the coal could be removed, and the timber would be taken away as the work proceeded. It is likely that this system could be used very effectively in some of the lower coals, which lie interbedded with hard strata, more especially some of the thinner ones.

The coal is taken down entirely by means of the pick. The variety used is a short straight head, with a handle of thirty inches. With this the miner very slightly "holes" the seam, and then hews it down. In this way much of the coal is spoiled, the greater portion becoming slack. No wedges are ever used to bring down the coal in large masses.

The men work in two shifts of from 8 to 10 hours each, and these are so managed that the miners have equal turns of day and night work.

The smaller pits, of which a great number have been opened at different times, are worked in an exceedingly primitive fashion. A single shaft suffices. It is 4 feet square, and from 8 to 20 yards deep. The "tubbing" or lining, is constructed of as little wood as possible, and a good deal of heather, and is neither as ingenious nor so effective as the wicker work or wattle tubbing of the ancient Belgians. Across the top is placed a "roll," or winch, often very ricketty, which being turned by two men raises and lowers alternately a pair of barrels, suspended by a rope, and answering for every purpose; raising of coal,

drawing of water, and conveyance of the men, who prefer this way to what they consider to be the less secure one of the steam-engine and wire rope. Pits of over 60 yards have been in existence quite lately with no better winding apparatus.

Sometimes the underground arrangements in these little pits are not at all bad, but in general carelessness and waste prevail. The coal is hacked down any way at all, and is churned into fragments ere it reaches the top. The want of proper unwatering machinery is generally fatal; as the men say, "the water beats them." Of course this is a state of things that cannot be avoided when, as often happens, the workings are undertaken by a few poor men who club together to share the labour and expense: but the same thing is being done every day by people who should know better, and should see that it is their own interest to have their apparatus on a proper footing. Winding is done by steam power at less than one-tenth the expense of horse-whims,* and tramwagons are considered to do the work of wheel-barrows in metalliferous mines at one-fifth of the expense.† How much more advantageous then must both be than the rude appliances in favour here. I believe that nearly all the coal that has been won in the vicinity of Coalisland has been got out by the expensive and barbarous way just described.‡

I will now give a list of such prices as are in common demand in the district.

For sinking shafts, the cost per yard varies with the diameter of the shaft, the nature of the ground, and the presence, or absence, of water, or running sand. In rather hard sandstone, and sandstone slate, with a good deal of water, a shaft 11 feet by $5\frac{1}{2}$ feet cost:—

	s.	*d.*	
For the 1st 20 yards, . . .	10	0	per yard.
,, 2nd ,, ,, . . .	15	0	,,
,, 3rd ,, ,, . . .	20	0	,,

Thus adding half the cost per yard, of the first 20 yards, each time.

* Captain Vivian of Wheal Towan, &c. Henwood's Metall. Dep. Vol. i. p. 142.

† Op. Cit., Vol. i. p. 143.

‡ One reason for this state of things is probably the ease with which an outcrop of coal may be struck on, owing, as well to the numerous seams as to their repetition sometimes by means of faults. When the workings are obstructed by a "trouble" it is thought to be the best plan to open a similar pit elsewhere. This too is due to the phenomena of faults being misunderstood. The idea is, that the coals lie in sets of distinct basins or "pounds," and that a "trouble" denotes the dying out, or out-cropping, of the seam under work. This opinion is very general, and is not confined to the illiterate; but it is a mistaken one. The general dip of the coal is persistently to the north-east or thereabouts; and though subordinate rolls occur, they never bring the coal to the surface so as to reverse the crop, save at the very extremity of the basin itself, and then only partially, and under the influence of a very powerful boundary fault.

In somewhat similar measures two shafts were sunk (belonging to one pit) about twenty feet apart, and five feet by four and a-half in diameter.

The cost of each was—

		s.	d.	
1st 20 yards,	. . .	7	0	per yard.
2nd „ „	. . .	10	6	„ „
3rd „ „	. . .	14	0	„ „

and so on.

Thus it costs proportionately more to sink a narrow shaft than a wide one: since there is less room to work in, the tools cannot be used so effectively.

When the coal is won the prices are as follows:—

		s.	d.		s.	d.	
Hewers get from	. .	1	6	to	1	8	per ton.
*Putters „	. .	0	6½	to	0	7	„
Banksmen „	. .				1	4	per diem.
Onsetters „	. .				1	4	„
Enginemen „	. .	20	0	to	30	0	per week.
Firemen „	. .	9	0	to	11	0	„

The hewers and "putters" are paid by the wagon or "bogie," or by the barrel or the ton. In some cases the hewers are paid 4*d.* per bogie of 4 cwt., in others 4*s.* 6*d.* per 20 bogies of 3 cwt. "Putters" get in some pits 1*d.* per bogie of 3 cwt., in others they are paid by the shift of 8 or 10 hours, 2*s.* The manner of payment differs, but the rate per ton comes to about the same thing.†

To these wages must be added those of the manager and clerk, and the "captain," whose position corresponds somewhat with that of the "Doggy" in Staffordshire collieries. These necessarily vary with the quality of the mine, but they are small indeed compared with those obtained in similar berths in England. A smith is sometimes engaged, but all wear and tear of tools is made good by the pitmen.

These supply their own tools, candles, &c. As there is no dangerous gas, a naked light is always used. A great saving might here be effected by the use of lamps, instead of candles. It has been estimated that the difference is at least 50 per cent. in favour of lamps.‡

Larch timber, six inches in diameter, costs about 10*s.* per ton weight. When the carriage is added, the cost for each ton of coal removed varies from 6*d.* to 9*d.* in ordinary cases. But in the main roadways the timber must be frequently renewed or added to.

---

* The boys who "put" or shove the tram wagons full of coal from the hewers to the bottom of the shaft.

† These were the usual wages up to last July. Since then there has been an increase of about 20 per cent.; but the rates now vary so much in different pits that it is impossible to make out a table that will suit all the cases.

‡ Records of Mining and Metallurgy. J. Arthur Phillips and John Darlington. Page 241.

About 8*d.* per ton must be allowed for coal consumed in the engine room.

Reducing everything to the cost per ton, the total working cost will vary from 4*s.* 8*d.* to 6*s.* 6*d.* When to this are added the royalties, the coal may be had for from 5*s.* 6*d.* to 7*s.* 6*d.* per ton.

Royalties range from 6*d.* to 2*s.* per ton on the different properties. The first is very reasonable, but the higher charges mostly prevail, and in many instances help to prevent the coal being sold remuneratively at such prices as would encourage a demand outside the immediate vicinity of the pits. In fact it is the interest of every one concerned to combine to produce such a result. There can be little doubt that a colliery in the Tyrone coal-field would prove a valuable investment if conducted on proper principles, and with a view to more than merely an immediate large profit. That there is a demand is proved by the enormous prices that are obtained.

It is thought by some that the working of iron mines in the county of Antrim may give an impulse to coal mining in Tyrone, by inducing the raising of coal for the use of the iron smelter. This, however, is rather a remote prospect. Most of the coal at present raised is quite unfitted for the production of fine metal, containing as it does a large percentage of sulphur.* I need not say that iron manufactured with such fuel would not be of the best quality. As the freight of ore to Scotland is not exorbitant, it is doubtful whether it would be worth while to purify the coal either by coking or washing processes. Still it is an important point, as affecting both coal mining and iron manufacture in Ireland. However, it will be time enough to think of it when a colliery has been got up sufficient to supply the local wants.

In conclusion, a few words on the manner of making trials, and boring, may be considered not out of place.

In making a trial for coal it is usual to begin by putting down a shaft for about 20 or 30 yards. For it is always hoped that coal may be obtained within that distance; and then the shaft serves both for the exploration and for raising the coal. It has besides the advantage of showing the nature and disposition of the strata passed through. If nothing has been got at the depth named, and it is determined to go on, a bore hole is commenced. Boring, as practised here, is extremely untrustworthy, and—unless a bed of coal is actually passed through—gives hardly any information worth getting. It is done according to the ordinary English system of well-boring—that is, by means of a common chisel-shaped borer, attached to iron stocks or rods, which is beat upon the rock whilst it is gradually turned round in the hole formed. This reduces the rock acted on to a state of fine pulp, which is from time to time withdrawn for examination, by means of a valved tube, called a "Sludger." It is anything but an easy matter to judge of the character of the rocks from the specimens that are thus obtained; and

* Some of the seams are, however, comparatively free from it.

it is certainly impossible to compare these with strata in the neighbourhood, so as to predict the approach to any particular bed of coal, so that those employed are often quite at fault.* In fact, it is a style of work that should never be employed for a trial.

The prices are as follows, the diameter of the hole being one and a half to two inches :—

	s. *d.*		*s.* *d.*	
For the first 10 yds. . . .	3 6	to	4 0	per yard.
,, second ,, ...	5 3	,,	6 0	,,
,, third ,, ...	7 0	,,	8 0	,,

thus adding half the cost per yard for the first ten yards to the last price. This is the rate for soft strata.

When the ground is harder, the rule seems to be to give for each ten yards one and a-half times the rate per yard paid for the preceding ten. In this way the cost increases very rapidly.

	s. *d.*	
For first 10 yds. . . .	4 0	per yard
,, second ,, . . .	6 0	,,
,, third ,, . . .	9 0	,,
,, fourth ,, . . .	13 6	,,

At the first rate a bore of fifty-four yards was put down in sandstone and sandstone slate, for an average of 8*s.* 6*d.* per yard.

At the next rate a bore of seventy yards, in somewhat similar strata, but containing beds of hard sandstone and coarse conglomerate, cost 12*s.* 10*d.* per yard.

Deep borings are seldom undertaken here, and at the rates calculated above are never carried beyond seventy or eighty yards. Both employers and men then prefer to commence working by the shift, or day.

The wages then become—

	s. *d.*		*s.* *d.*	
Head borer, ...	3 0	to	6 0	per diem.
Second do., ...	2 0	,,	3 6	,,
Labourers, as many as are required,	11 0	per week.		

In all these cases the employers provide the tools, and make good the wear and tear.

Sometimes the following prices are given—

	s. *d.*	
For first 20 feet, . . .	1 0	per foot.
After that ,, first 10 ,, . . .	2 0	,,
,, ,, 2nd ,, ,, . . .	3 0	,,

And so on until the rate becomes 8*s.* per foot, when a new agreement is made as to the remainder.

* To add to the confusion, the joints of the rods act as borers, and cut away portions of the upper beds, which become mixed with the mud at bottom, and make it more difficult of identification.

This estimate is for hard rock, and the men provide the tools smith's work, &c. It is only suitable for shallow wells, as, in a deep trial, it would run up to an enormous expense.

The method under notice should seldom be used, even for wells, and never for explorations. For the latter it is, I believe, almost useless, and the cost is simply money thrown away. I know of more than one case where the borers are in doubt as to whether they passed through a thick bed of coal or not; and their descriptions of the strata gone through are generally extremely loose. The tool for such work should be one like the crown borer of M. Kind, by which a core of rock can be taken up, and its character unmistakeably determined. It is remarkable that this is not tried here, for not only is it quick and effective, but it is also the cheapest method known. By this system a bore of 200 yards can be put down for an average cost of less than £1 per yard. While, by the other way, the cost would probably treble this; if, indeed, it would be done for it—and, after all the trouble, expense, and time, the explorer would be, perhaps, no wiser than before.

If the Dungannon coal-field is ever to repay a mining enterprise, the attempt will only succeed if it be made according to modern and scientific modes. It seems to be thought a sufficient excuse for using obsolete and slovenly methods, that there are certain difficulties of strata, &c., to be overcome; whereas, this is the very best reason in the world for proceeding in such a way as experience in other localities as proved to be the most economical.

XXVIII.—*On the Successful Establishment of Loranthus Europeus on Oak Trees in the Botanic Garden, Glasnevin, with Observations on the Cultivation of other Parasitical Plants therein.* By David Moore, Ph. D., Director of the Botanic Garden of the Royal Dublin Society, Glasnevin.

[Read January 21, 1873.]

To introduce the European Loranthus to oak trees in the British Islands has long been an important desideratum among botanists, horticulturists, and amateurs. It has, to my knowledge, been tried on several occasions without success, and so far as I am aware, there is no instance on record of this singular parasitical plant having been seen in a growing state in Britain or Ireland, until we have at last got it established at Glasnevin. To afford those who are not acquainted with this plant some idea of its nature and habits, I shall liken it to the Mistletoe, *Viscum album*, which most of us know something of about Christmas times. It and the Loranthus belong to the same natural order of plants, and are true parasites, growing only on such trees as they select for supporters,—hence the difficulty of getting them established by artificial means. The Mistletoe prefers pomaceous trees

to grow on, but is not exclusively confined to them, and it is rarely found on the oak, whilst the Loranthus appears chiefly to select the latter as a support and feeder. Those of us who have been much through the southern counties of England, know how abundantly the Mistletoe grows among the fruit-tree orchards there, where it not unfrequently gains complete mastery over some trees, and breaks them down by its weight.

In Austria and some parts of the South of Europe, the Loranthus prevails similarly among the oak trees of those countries. Having now succeeded in establishing both of those plants on their respective supporters in the Botanic Garden, I shall give a brief sketch of the methods resorted to for that purpose. About thirty years ago the only Mistletoe plants in Ireland, that I was then aware of, were three; one at the College Botanic Garden, Ballsbridge; another recorded by the late Dr. Wade, which he saw growing on a crab apple tree that had been imported from England, probably the same as that mentioned by Rutty in his "History of Dublin," as growing near Island-bridge. There are also some old plants of it in the garden of Thomas Acton, Weslaston, Co. Wicklow. They had all been artificially propagated, as the Mistletoe is not a native of either Ireland or Scotland, but it is now beginning to spread in Ireland. At that period the late Dr. Whately, Archbishop of Dublin, who was so enthusiastically fond of everything connected with vegetable physiology, became aware of the scarcity of Mistletoe in Ireland, and brought with him from England a quantity of the berries or seeds, part of which he gave to me to try my hand at cultivating, and kept a portion himself for a similar purpose. It may here suffice to state we both succeeded in getting plants to grow from those seeds, the details of which I gave in a former communication on this subject to the Royal Dublin Society, and now there are many plants in various parts of this country.

At Glasnevin there are at least a couple dozen branches of mistletoe growing on six different kinds of trees, but we have not yet been able to get any established on conifers, though I have seen it growing abundantly on pine trees near Darmstadt, in Germany. In both genera, Loranthus, and Viscum,—the seeds of the species belonging to them are surrounded with a white pulpy viscous matter, which causes them to adhere to the boles and branches of the trees on which they grow naturally, and which is most essential in aiding their artificial culture. In the case of the Mistletoe, it is only necessary to take the ripe seeds and press them with the fore-finger and thumb against any smooth healthy part of the bark of the bole or branch of an apple, pear, thorn, lime, mountain ash tree, or even a rose bush. In performing the operation, care should be taken to avoid rough hardened parts of the bark or chinks, and also not to cut the back in order to place the seeds in the cuts, which is so frequently done by those who are inexperienced in the matter.

The viscous gelatinous substance soon becomes hardened over the seeds, and binds them firmly to the points of attachment without the

aid of any ligature. About a month or so after the time the seeds are placed on the trees, they begin to swell, and soon afterwards push out one or two rootlets, as the case may be, divergent from the point of attachment. They are slightly concave at their apex, and recurve backwards to seek the supporting body, which on reaching, they adhere to like suckers. The other ends of those rootlets being still adherent to the seed, they form at this period of their growth a bow or irregular semicircle; the ends so attached soon afterwards leave the seed, grow erect, and become the plumules. During this process the sucker-like root which has rested on the surface is gradually pushing its way through the bark until it reaches the alburnum, where it feeds and nourishes the plumule, while the latter continues to elongate. These plants do not appear to have the power of penetrating farther into the woody system of the trees on which they prey than the alburnous wood, between which and the last layer of the bark they continue ever afterwards to feed.

Many of them, however, send out from the first point of attachment suckers parallel to the axis of the supporting trees, which at some considerable distance burst through the bark and extend themselves into branches. This circumstance was noticed long ago by Griffiths in his important notes on the development of the Ovule of Loranthus and Viscum and their parasitism, in "Transactions of the Linnean Society of London," vol. viii., p. 71. From the specimen on the table which I had prepared some years back to show the nature of attachment between the plants and parasite, it may be perceived that the base of the latter has gradually become imbedded, according as the annual layers of wood of the supporting plant increased after the parasite was first fixed on it, but no roots have penetrated further towards the pith of the tree than they did at first attachment. I was desirous to ascertain whether the parasite had any power of enabling the supporting plant to make its wood by the aid of the action of the leaves of the former. Our experiment was to denude a branch of an apple-tree on which a strong plant of Mistletoe was growing, of all its natural leaves, from which it was kept bare throughout the season. This was repeated a second year, after which the branch turned sickly and was cut off. The only difference we could perceive was, that the two annual layers of wood made during the progress of the experiment were much thinner than those made on previous years, a result which was to be expected, but it did not appear the parasite had any part in forming the wood. Having now detailed the process for the propagation of the Mistletoe, I shall next allude to the successful introduction of the Loranthus Europeus, which forms the principal object I have for making this communication. Some twenty years ago, a friend of mine who was well known among amateur horticulturists, the late Bellenden Ker, visited Ireland and felt interested with our success in growing the Mistletoe. He then told me he intended to proceed to Vienna, when I begged of him to try and get me some fresh ripe seeds of the Loranthus from the oak trees of that neighbourhood. After his arrival

there, he wrote to me and stated he had seen the parasite, but the seeds were not ripe. He however managed to arrange with the late Dr. Schott, Director of the Imperial Botanical Garden at Vienna, to send me some as soon as they ripened, which the latter accordingly did. On their arrival we lost no time in applying them to the bark of oak trees, similarly, as we had succeeded with the Mistletoe on the bark of apple-trees, &c. The late foreman, Mr. Macardle, put on a number, and I tried a good many myself, some of which continued fresh-looking a whole year, but ultimately fell off without one of them taking root, a result which chagrined both of us very much. When thinking over the matter afterwards, it occurred to me we had probably not taken the right method of applying them, which made me long for another opportunity to try and establish them. This happily offered in 1869, when I met Dr. Fenzl, Professor of Botany to the University, Vienna, at the Botanical Congress which was held at St. Petersburg during that year, and who kindly sent to us the fine example of Loranthus Europeus now before you, in January, 1870, when it was covered with ripe seeds. At same time he stated, that he thought we should not succeed in getting them to grow, as he had never known any instance of the plant having been propagated artificially, save one. We however set to work with them. Mr. Kiet, the propagator, tried a considerable number of the seeds in various ways on oak trees, and probably I tried as many more myself, and Parnell, the present foreman, put on a few also. Some were again made to adhere to the exterior of the bark, others were put under its epiphleum, and more under the endophleum, resting on the alburnous wood, but by none of these methods were we successful. It occurred to us to bruise gently the soft bud on a young shoot of the previous year, and insert the seed of the parasite in the centre of the partially bruised young bud. By this method two of the seeds grew, one on the common oak and one on the Turkey oak, *Quercus cerris*. Although the progress of their growth up to the present period has been remarkably slow, it is still sufficient to warrant me in reporting the success of the experiment. The seeds which were put on in January and February, 1870, soon became covered over with their viscous gelatine, which hardened and appeared like transparent glue, in which they remained until the Spring of 1871, when it fell away, and soon afterwards a few young leaves of the parasite were pushed out from the bark of the oak branch, thus showing it had taken root. The leaves continued to enlarge until the Autumn of same year, when they were subject to the natural habit of the plant, and dropped off deciduously. In April of last year, 1872, about a dozen of leaves of the Loranthus grew at each of the places where those of 1871 had been, and continued healthy all the Summer, until the fall of the leaf in Autumn, when they again fell off. No branches have yet grown, but there can be no doubt that the parasite has taken vital hold on the trees; and as I have now detailed the method we took to propagate it, we may expect that other experimenters will endeavour to cultivate

this curious plant, which from so small a beginning may ultimately become of frequent occurrence in the British Isles. In the memoir I have already alluded to by Mr. Griffiths, he remarks, that although it be the case with the majority of Loranthaceæ to send out sucker-like roots between the bark and wood of the supporting tree, yet he states, "I have reason to believe, however, that in some Loranthi and Visci, the attachment takes place by one spot, in other words that there is only a primary attachment." Whether Loranthus Europeus may accord with the latter case, I have not sufficient experience of it to state, but judging from the large example before us, no sucker-like branches have been produced; the whole plant has adhered to the primary point where it first became attached.

While on the subject of cultivating parasitical plants artificially, it may not be considered out of place to mention the following kinds which are now fully established at Glasnevin:—

1. Orobanche Hedera, Duby, growing on Ivy. Propagated by bringing in roots of Ivy which were infested with the parasite, and grafting them on roots of Ivy which was growing in the garden.

2. Orobanche minor, Sutton. Growing on the roots of Trifolium medium. Propagated by sowing the seeds of the parasite along with the seeds of the clover.

3. Lathræa squamaria. Growing on the roots of several kinds of trees. Propagated by digging up tufts of the plant and planting it among the roots of trees growing in the garden.

4. Of Cuscutas we have had six different species growing in one season, but they are not permanent, and require for the most part to be kept up by sowing their seeds annually, and assisting them to attach themselves to the supporting plants on which they prefer to grow.

We have made several attempts to establish the yellow Birds-nest, Monotropa hypopitys, and also the common Birds-nest Orchid, Neottia nidus-avis, but hitherto without success. The latter lived and flowered a second year after it was brought into the garden, which gives some hope of success by farther perseverance.

XXIX.—*Comparative Trials of Artificial Fertilizers.* By Professor TANNER, M. R. A. C.

[Read January 21, 1873.]

THE experiments which have been carried out for the purpose of determining the action and value of Fertilizers are not only very numerous, but represent a vast amount of personal labour and expense. The data which have been obtained from these experiments cannot be looked upon as affording conclusive or even satisfactory evidence. The practical experience which has been gained is of a very restricted character, and although it has a certain local value, yet it is still

acknowledged to be indefinite and uncertain when its more general application is attempted. There is a want of harmony in the views entertained in the laboratory, in the manufactory, and in the field; although in each case there is a sincere and genuine desire for the truth. As a necessary consequence, although certain general principles have been accepted, and under certain conditions and circumstances are probably correct, still it may be safely affirmed, that the principles which should regulate the production, and the employment of fertilizers, are vague and indefinite.

If our experience has taught us one lesson more distinctly than another, it is that the evidence afforded by careful experiment in the field can alone be accepted as safe data on which to base correct principles. Whatever may be the special opinions held respecting the action of fertilizing matter upon vegetation, unless these stand the test of practical trial upon the land, they must be looked upon as theoretical probabilities, and nothing more. Difficult as such a course of procedure undoubtedly is, we are bound to acknowledge the fact, that the evidence of practice must be our guide. Numerous instances might be adduced to confirm the necessity for such a course of procedure, but it is needless to do so, as it will be readily admitted that the application of scientific principles can be more advantageously carried out, after we have deduced from practical operations in the laboratory of Nature some definite indications of their action.

We must also recognise the fact that in the use of fertilizing agents, for increasing the productive powers of the soil, we have several agencies influencing the result—agencies which are not only powerful in their action, but variable and inconstant—and this is the real difficulty which has to be overcome.

In the selection of Artificial Fertilizers, the farmer has several distinct classes from which to make his choice, and in doing so he is bound to take for his guidance the practical experience he has gained on his own farm, and from observation in the district around him. By common consent, the Phosphates have been acknowledged to be most generally useful, and by various chemical investigations the cause of this success has been satisfactorily explained. In the form of Superphosphate of Lime, the demands are so large, that the manufacture has rapidly risen into one of the highest importance and magnitude, and the value of this form of Phosphate is unquestionable. If we remember that every form of agricultural produce which is sent to the market carries away with it its quota of this material, it will allay any surprise that its restoration to the land should be so generally useful and remunerative. There are however exceptional instances, in which the Superphosphates are not productive of any advantage, and their use a simple waste of money. The cause of this we shall hereafter refer to more fully. Observant farmers have already to a great extent determined some of these districts, and in many cases adopted measures for preventing these losses. As a class it will, however, be readily admitted that Superphosphates are exceedingly valuable as nutritive manures.

Ammoniacal manures have also attained a well-deserved and acknowledged value, but their high cost has greatly limited their employment. From this cause we do not possess that practical evidence as to their action, which we have of other classes of fertilizers, still quite enough is already known to lead to the conclusion that, whilst under certain circumstances they are very valuable, in other cases the advantages gained do not remunerate for the expense involved in their use. It must not, however, be overlooked that, by the judicious production and management of Farm-yard manure, large supplies of ammoniacal fertilizers are at command, and which to a great extent limits the necessity for the purchase of these supplies. This becomes the more important when the price of Ammonia is as high as at the present time, viz., about £100 per ton, whereas the home production, by a judicious use of food, is in every way consistent with the most improved farm practice, and is generally by far the cheapest source from which it can be obtained. In brief, whilst we do not possess any definite knowledge to determine with accuracy the conditions which command success, we may remark that ammoniacal manures, although they are expensive, yet under judicious employment they are most valuable and remunerative stimulants, encouraging a healthy growth and abundant crops.

The Nitrates are another class of fertilizers, and of almost equal importance to those previously noticed. In some respects they exercise an action similar to ammoniacal manures, but they manifest peculiarities which show that they cannot be recklessly substituted the one for the other. Here again the system of home production in compost heaps exercises an important influence on the required supplies. It may be said of the Nitrates, that as a class they are powerful for good or for evil. Judiciously employed, they are valuable stimulants of luxuriant growth, but at the same time they are capable of great injury to the land; and as whips they leave a record behind.

The Potash Salts are of unquestionable value, but the evidence of practice is at present exceedingly confused. In many cases they are very valuable and remunerative—in other cases they are unproductive of any apparent benefit,—but sufficient is already known for them to be accepted as valuable manures, which will be welcomed assistants for farm cultivation, when we are more fully acquainted with the conditions, and circumstances, which are favourable for their employment.

Salt is another manure which claims a passing notice. The experience arising from its employment enables its action to be referred to with some confidence, but we have much more to learn as to its character than we know at present. It presents a curious anomaly in its action, of which we shall ere long make a more perfect use. Practically, it throws a check upon luxuriant growth, and yet it favours a more perfect development of the crop. It acts as a drag to the carriage wheel, and makes the progress more safe. It checks the

formation of new cells, whilst it assists in filling those already constructed, and it not only makes the general growth more healthy, but it improves the nutritive character of the crop.

These Artificial Fertilizers may be taken as representatives of the entire class; and although they have been noticed with great brevity, and necessarily in a very incomplete manner, still, enough has been said to show how varied are the influences they are capable of exercising. A closer examination would have shown that they possess depths which are not touched by such a superficial notice, and which will for years to come offer a wide field of research for our ablest investigators. Judging, however, from the facts as they appear before us, it is clear that, in the selection of his fertilizers, the farmer has little to guide him, but the practical experience he has gained on his own farm, and from observation in the district around him. No one can value the importance of this knowledge more highly than he does, and it is well for him that he should do so, for it will save him from many speculative errors which to him would be costly. These convictions we may term prejudices—and many an effort has been made to remove these so-termed prejudices—but containing as they generally do some germs of truth, it is well for him to be first satisfied that the substitute is more accurate. But whilst the value of this practical experience is undoubtedly great, those whose knowledge is the most advanced will be most ready to admit its imperfect and incomplete character, and earnestly do they desire more facts by which to attain greater success in their operations.

Admitting then the paramount value of practical experiments for determining the proper use of fertilizers, it is very desirable to consider how it is that the numberless experiments which have been made have failed to give any clear and distinct data, from which we may deduce the principles which should guide us in the use of the various fertilizers. The cause is undoubtedly to be traced to the fact, that whilst the endeavour has been made to determine the influence of any one fertilizer, there have been other agencies exerting their influences at the same time—some favourably, and others unfavourably—and thus rendering it very difficult to determine to what extent the selected fertilizer had contributed to, or accomplished the result attained. We may briefly refer to some of these agencies, and notice the manner in which they interfere with the direct determinations desired.

The influence of the soil naturally presents itself as one of the most prominent of the agencies which must affect the trial of any fertilizer. The soil is the source from which the mineral constituents of the crop must be drawn, and the manure employed really occupies a secondary position, by simply supplementing the supplies of food already present. In fact, as soon as the manure is added to the soil it becomes incorporated with it, loses its own special identity, and becomes part of the soil. The necessity for any such addition of fertilizing matter is obviously dependent upon the composition of the soil, for if any

material be present in sufficient abundance, any furthur addition is unnecessary. On the other hand, should there be a deficiency of any required material, its supply by means of manure is clearly desirable. Looking at the matter from this point of view, it would appear probable that a chemical examination of the soil would indicate the measure of success which would arise from the use of any fertilizer. It will, however, be inquired, how is it that the chemical analyses of soils have so distinctly failed to afford these indications—at any rate with that accuracy which we had a right to expect? Our surprise will be removed if we look at the facts more closely. We have in all soils a certain proportion of the materials existing in a form available for the support of vegetable life, and we have the residue in a latent form—a store for future years. This latent portion exists in various conditions—some is in a transition stage, some advancing towards it, but at various distances, each ready to follow and replace its predecessor in due course, but still maintaining a progressive series of supplies. In obtaining an accurate analysis of any soil for agricultural purposes, it is necessary to isolate that which is absolutely the available matter of the soil, for this alone represents what is at command for the next crop; but inasmuch as more than this available matter is usually extracted from the soil for the purposes of analysis, we have a result which embraces much which will not come into use until future years arrive. With scrupulous care, by far the greater portion of the fertilizing matter of the soil is, as it were, locked up in the land, a safe provision for many future years, and only a very small portion is available for immediate use. Any calculation which embodies more than is really available is likely to mislead, and unless this is isolated, and definitely estimated, the chemical analysis of any soil cannot be relied upon for indicating the deficiency which has to be supplied.

In the varying absorptive powers of the soil, we have another exceedingly important agency which has been sadly disregarded. This power of holding manure has been shown to be largely, if not entirely, dependent upon the condition of certain constituents of the soil, which enable a definite chemical action to take place, whereby various fertilizing matters are held, until taken up by vegetation. I refer with much pleasure to the important investigations of Professor Way, originally published in the Journals of the Royal Agricultural Society of England, which clearly establish the fact, that the silicates of the soil are—under certain conditions—capable of performing this duty in a very perfect manner. It will be evident that the degree in which this power is possessed by soils must have an important influence upon the use of any soluble manure, and cannot be safely disregarded in any estimate of the relative action and practical value of any fertilizer.

The physical character of the soil claims our attention, for it also plays an important part, especially in relation to the influence of climate, for the one largely modifies the action of the other. Take, for example, the difference between a close and retentive clay soil in a wet

climate, and a porous sandy soil in the same district, and it will be obvious that these soils must differ materially for the purposes of agriculture, and, consequently, in the advantageous employment of similar fertilizing materials.

The influence of climate is another agency which in practice will exert its full influence, however much we may disregard it, in our calculations. Not only are the soil and the manure brought under its action, but the growing crop is especially affected by the climatic influences to which it may be subjected. We are, therefore, compelled to give particular attention to the influence of climate in forming any conclusion as to the value of a manure.

The influence of the seed, in connexion with the experimental trials of manures, has been in general very much disregarded, and yet it is probable that it has a greater influence on the result than the quality of the manure used. Here we have the germs of those organisms by which the crop is to be produced—here we have, as it were, the builders who are to utilize the materials presented in the soil, and the fertilizers we employ—on their constitutional strength, and aptitude for the object to be attained, we are dependent for success; and yet how little regard has been paid to the living organism which has to accomplish the task. Attention has been too exclusively given to the food supplied, rather than to the capabilities of the plant for making use of that food. We recognise this influence in animal life, and carefully secure in our improved breeds of stock those special tendencies which most perfectly utilize the food we give. We know that the food we employ can be more or less economically utilized, just in proportion as we regard or disregard those conditions of life which influence and control the desired result. We do not content ourselves by testing one kind of food against another, regardless of the capabilities of the living structure by which the work has to be done. It would now be regarded as a great error of judgment to expect, that as good a result would be obtained by giving an equal weight, of equally good food, to an inferior animal as to one that has been well bred, and which possesses great aptitude for the production of meat. In these cases we fully recognise that it is not the food alone which controls the result, but the natural character of the vital organism by which the structure has to be built up; the same principles apply to vegetable life in a somewhat modified form. It is well known that any special aptitude observed in a plant can be encouraged and rendered more perfect and more permanent by careful cultivation; the entire system of cultivation declares the principle to be true. Every farmer is aware of the fact, that to maintain the quality and productiveness of his crops, he must have a "change of seed," although the principles involved are very imperfectly understood. But whilst these facts have received attention for some of our farm crops, they have been greatly disregarded for others; and in the case of the seed for root crops, this is more particularly the fact. Many a laurel has been won from inferior manures by a careful selection of seed, whilst many a good manure has

borne the discredit of a failure, which more justly belonged to the seed. Experienced competitors for prizes for the best crops grown with certain manures could—if they would—communicate many a secret about the seed they use. They treat it with the same watchful care as they would bestow on a race-horse, or a greyhound, or stock intended for exhibition. Here the truth is recognised, but the day is not far distant when it will be generally looked upon as largely influencing all our agricultural operations, and especially all experimental trials for determining the relative value of fertilizers.

The condition of solubility in which any fertilizer is employed necessarily influences its economical use. On the one hand, waste has to be avoided; on the other, a sufficient supply has to be maintained, ready for the requirements of the crop, during its several stages of growth. This is necessary in the case of each and every material required by the plant; but as an illustration of the principle, we simply notice the Phosphates of Lime. The earliest form in which these were used as manures was as bone more or less finely broken. The results obtained were satisfactory and encouraging, but the manure was slow in coming into operation. In 1840, Liebig purposed, that they should be treated with Sulphuric Acid, so as to quicken their action, and enable the outlay to be more quickly repaid. This was the first introduction of a new system of manufacture, by which great wealth has been accumulated—a manufacture which has since undergone certain economical improvements—and has now become a trade of surprising magnitude and importance. It has unquestionably given an impetus to agriculture, from which the greatest benefits have arisen; but notwithstanding this great success, many practical men have raised the caution signal, and suggested inquiry, with a view to obtain still greater advantages. Let us briefly see whether there is any just cause for this caution, or for the hope they entertain.

The term soluble phosphate has become very familiar in agricultural and commercial circles, as it has been accepted as indicating the quality and value of Superphosphates. It is a term used by chemists to particularise a certain definite form of phosphate of lime, in which one equivalent of phosphoric acid is combined with one equivalent of lime. It has been commercially assumed that this is the only form of soluble phosphate, and thus we have insensibly glided into an error. It is well known to chemists, that there is another* form of phosphate of lime, which is also soluble in water. This form of soluble phosphate differs in a very marked degree from the ordinary soluble phosphate, not only in its composition, but also in the conditions of its solubility. Instead of having one equivalent of lime, combined with one equivalent of phosphoric acid, it has two equivalents of lime so combined, and it requires a very much larger quantity of water to take it up in solution.

---

* There are other forms of Phosphate of Lime which are also soluble in water, besides those specially referred to.

It may be fairly asked, does this make any practical difference in the agricultural value of phosphatic manures? There need be no hesitation in stating that it does; and herein lies the explanation of some of those differences which have arisen between the practice of the farm and the deductions which have been made from laboratory examinations. In the gradual decomposition of unmanufactured bones in the soil, we do not have that form of phosphate of lime produced containing one equivalent of lime, but we have the slowly soluble phosphate of lime formed, with its two equivalents of lime. Here again is the explanation of a somewhat popular error, that bones when they have been treated with sulphuric acid, whilst acting with greater rapidity, do so in a similar manner. Such treatment with Sulphuric Acid, as it is usually practised, of necessity produces a large proportion of rapidly soluble phosphate of lime; and if the treatment with acid be carried on to the full extent of the manufacturer's power, it takes this form entirely, whereas this form of soluble phosphate cannot be produced when the bones decompose in the soil. In many cases superphosphates "go back" in their percentage of soluble phosphate, after they have been made, and consequently are known as "reduced" superphosphates. The loss thus thrown upon the manufacturer is very great. This loss arises from the fact, that under the analysis which is to indicate the commercial value, it is only that portion which has not "gone back" which is estimated. The opinion held by manufacturers of the hardship thrown upon them has met with a responsive echo from the consumers, who generally consider that superphosphates which have "gone back" have a better and more lasting action than their analysis indicates. Thus it has been recognised in the trade, that certain forms of phosphatic manures analyse badly, whilst their effects on the land are excellent; and other phosphates analyse well, when they are unquestionably inferior in their action.

One well-recognised feature in the action of these "reduced" superphosphates is the influence they exert on the root crops in the latter stages of their growth. The production of a heavy weight of highly nutritious bulbs is the object to be attained in the successful culture of our root-crops. We do not desire to see a rapid and high-pressure growth in the early stages, which rushes the crop into mildew when the first check arises, but a steady and continuous development of the crop; and more particularly so in the finishing stage of the plant's growth, when the cells are being stored with the most nutritious food. If the manure and seed both favour an excessively rapid growth, there is not sufficient time for the cells to be firmly constructed, and it often happens that, before they can be filled with the nutritious food for which they were destined, decay commences, and the feeding value of the crop is excessively small. Here is the striking difference between the action of a phosphate of lime which is rapidly soluble, as distinguished from that other form which is more slowly soluble, and which, whilst fast enough, is not too fast. Now, it cannot be too distinctly stated that the present mode of estimating the value of superphosphates has acted

most unfairly on the best manufacturers, and has practically compelled them, against their better judgment, to go in for what may be termed "racing" superphosphates, which analyse well. The loss these "reduced" superphosphates are supposed to have sustained is really their special excellence. We have, also, a singular confirmation of these views, if we notice the description of soil on which superphosphates give their most satisfactory results. It is, with scarcely an exception, on soils in which there is carbonate of lime present. Now, we know, as a matter of fact, that, when the rapidly soluble form of phosphate of lime is added to such soils, it almost immediately "goes back" into the form of the slowly soluble phosphate of lime, and its work is characterised by a steadiness of action which is not observable under any other circumstances. Under certain conditions of soil and climate, we shall, doubtless, find it desirable to carry forward the manufacture as at present; but it may be stated, with equal confidence, that, under other circumstances, this will not be done. This, however, can only be determined by a series of careful experiments in the field. Embodied in this question there is an annual saving for the manufacturers supplying the United Kingdom of from £100,000 to £200,000, and for the consumer probably four or five times that amount. It is, therefore, a very serious and important matter for both parties. That there are difficulties connected with the estimation of these "reduced" superphosphates, no one for a moment doubts; but difficulties, when they are discovered, receive but one treatment—they are surmounted. To carry forward the manufacture beyond what is, in the opinion of the maker and the buyer, most desirable, simply to meet the present accepted mode of estimating the value of superphosphates, is so manifestly against public interests, that when the truth is recognised the practice must cease.

It is also worthy of comment, that although we have drifted into the employment of one class of phosphates, viz., phosphates of lime, there is no reason to believe that other phosphates are devoid of value, and yet they have been absolutely neglected; here again is a fine field for experimental research.

In the judicious combination of manures we have scope for the exercise of the highest ability, with every prospect of increased advantage and economy. It must, however, be admitted that whilst we have such indefinite views as to the most economical employment of individual fertilizers, that we are still more deficient in that knowledge which should regulate their combined use. Enough, however, is known to afford proof that when such information has been acquired, it will be of the highest value.

And, finally, it should be borne in mind that in estimating the produce obtained from any fertilizer, we have not simply to regard the weight of the product, *but its quality*. We commonly hear of certain fertilizers producing 30, 40, or 50 tons of roots per acre, as if these weights indicated the result, whereas farmers know perfectly well that the feeding powers of the lesser weight (30 tons per acre) may be of

more value than those possessed by the greater weight (50 tons per acre); and if so, the order of merit may be exactly reversed. The object to be attained is not simply the production of the greatest weight, independent of quality, but the production of the largest quantity of the most nutritious matter.

The more important agencies which influence experimental trials of fertilizers have thus been rapidly glanced at; and it will be evident to any one acquainted with the experiments which have hitherto been carried out, that these conditions have rarely received that attention which they demand. We have in fact a series of conditions to deal with, of the most variable and inconstant character, and this difficulty has been increased by the fact, that few experiments, if any, have been carried out under circumstances which admit of a proper comparison being instituted. It is to meet this difficulty, that it has been suggested that experiments should be carried out in this country, under an arrangement *which shall admit of the results being strictly comparable.*

It has been proposed to select a series of stations in different parts of Ireland, so that each geological formation and each variety of soil shall be operated upon, the chemical and physical character of these soils to be examined, the peculiarities of climate recorded by meteorological observations, the manure and seed employed to possess an uniformity of character, the cultivation to be carried out as approximately as circumstances permit, and the produce weighed, and its quality determined. With a view to simplify the course of operations, it is proposed, in the first instance, to limit the fertilizers used to one class, viz., phosphates of lime, and to supply them in various degrees of solubility, so as to determine the laws which regulate the action of this description of manure upon various soils and under different conditions of climate. By the adoption of this course of procedure, the number of variable conditions will be diminished, for the cultivation, the manure, and the seed at each station will be as nearly alike as possible. The soil and the climate will then remain as variable conditions, and these will be examined, observed, and recorded, so that their respective influences may be determined. When the experimental trials have fairly indicated the special peculiarities of the phosphates of lime, other fertilizers may be treated in a similar manner, and their respective influences determined. In this way it is anticipated that, whilst practical agriculturists will have the fullest opportunity of forming their own opinions by these trials in the field, those who seek to deduce from these experimental trials the principles which regulate the action of fertilizers will have full scope for scientific research.

The subject with which we are dealing is by no means one of little practical importance; it is calculated greatly to benefit the commercial success of the manufacture of artificial manures; it deeply affects the interests of every cultivator of the soil, and consequently every owner of land; its influence on the prosperity of the agricultural com-

munity is not to be calculated by thousands of pounds annually, but by millions; it offers a field of research for men of every branch of agricultural science; and it is deservedly worthy of encouragement by the Royal Dublin Society—a Society which has already inscribed upon its banners many noble achievements in the paths of Practice and Science.

XXX.—"*State of the Sea-Coast Fisheries of Ireland.*" By Wm. Andrews, M. R.I. A., Chairman of the Committee of Natural History.

[Read February 3, 1873.]

In submitting this evening the statement with reference to the "Irish Sea Coast Fisheries," it must be considered as an adjunct to the Report of the "Trustees for Bettering the Condition of the Poor of Ireland," especially directed to the coast fisheries, who have just published their Transactions for the past year (1872).

As there are many points of interest and explanations which could not be embodied in that report—"the forlorn hope of the Irish fisheries"—I have ventured, as one of the honorary secretaries of that Society, to notice such in the "Proceedings of the Royal Dublin Society," as the proper channel through which every species of Irish Industry should be made known and encouraged. In doing so, it will clear much of the mystery that has ever been a cloud over that branch of national enterprise.

It is not necessary here again to allude to the importance with which the British fisheries have always been considered in past reigns, and by past Governments of British Legislature, and to all the Parliamentary Acts which have been discussed and passed for their better promotion, and it would be invidious to consider what has been done either for England or for Scotland in comparison to that of Ireland, for I have always believed that the fault rested with ourselves, and to our apathy and neglect of well-founded representations of the subject. I shall therefore simply give an outline, commencing with the period when the Irish fisheries received a stimulus from Imperial Legislature in the year 1819.

It is an impossibility, previous to that date, to show, with any accuracy, the number of men, boats, and means employed in the fisheries, for documents so completely vary, that any statistics of the kind could not be depended upon nor maintainable. Indeed such views may, with propriety, be carried through all the returns from that period to the present time. The Act 59th George III., c. 109, with its several sections, did apparently an immense amount of good in stimulating the fisheries. Four Inspectors-General, one for each province, with station Inspectors, were appointed to see the several provisions of the Act carried out. A section of that Act, which gave bounties on tonnage, brought into play

numbers of speculators, who rushed into competition with every species of craft, for the accounts of the fisheries for 1820 report an old brig of 78 tons, and trading sloops of 67 to 55 tons, clearing out for the herring fishery. Many of these vessels went to Scotland, bought their fish, dallying out their term of three months, and then returned, receiving the bounty. The fishermen who had entered their vessels considered they were justly entitled to the bounty by only wearing out their time. In fact, Mr. James Redmond Barry, the Inspector-General for the South, observed "that he never had considered the bounty system anything better than an encouragement to fraud and indolence."

The Reports of the Inspectors-General for 1820 and 1821, published in 1823, convey but little information of value, their knowledge of the fisheries of those days being rather antiquated; still, no question but that great zeal was manifested by the superiors and their officers in the promotion of the fisheries. W. H. King, Esq., Inspector-General, whose district extended from Killala Bay to Kerry Head, I had, when a boy, frequently met. He had been in the Royal Navy, and though knowing but little of the fisheries, he was most zealous in exploring some of the banks, off the coast, and advocated strongly the deep-sea fishery. It was he who suggested, in his Reports of 1820 and 1821, the cutting of a canal, the Bell Mullet, the narrow neck of land that divided Broadhaven Harbour from Blacksod Bay, and which was twenty years after undertaken and completed, as shown by the Nineteenth Report of the Commissioners of Public Works. It was a most important navigation to small boats, saving their rounding the wild headlands of Achill and of Erris, and at the time would have been of infinite use to the boats of His Majesty's cruisers in the prevention of smuggling. Fishing, at that period, was but a secondary employment to the men of the coasts, to such an extent was smuggling carried on. From the entire range from Loop Head to Hag's Head, on the coast of Clare, an iron-bound coast, were numerous fishing villages, in which resided a hardy race of corrach or canoe men. The banks off the coast gave the finest turbot and haddock, and two days' fishing in the week were sufficient for all demands. Their canoes, by hundreds, were ever ready to launch on the appearance of a smuggler off Baltard, Malbay, or Liscannor, clearing out the smuggler's cargo of tobacco and brandy, hollands, &c., in a night's work. Large luggers, and the notorious "Big Jane," which was more than a match for the finest Cutter in the service, were always hovering off the coast. There were splendid cruisers on the look out; and I have seen in the Shannon the "Arab," "Sappho," "Gannet," and "Brazen," sloops of war, with cutters of a very large class—"Nepean," "Griper," "Vandeleur," and "Whitworth," and "Richmond" schooner. These smuggling canoe-men all swelled the Fishery Reports as men engaged in the fisheries, and others whose pursuits were picking kelp, poteen-making, and tillage. I recollect dining with Captain King on board the "Vandeleur" cutter, in Scattery Roads, commanded by

Lieutenant Napier, R. N., when information was brought of the "Fox" lugger (afterwards captured) being off Malbay. The "Vandeleur" immediately got under weigh, stood down the Shannon, but on rounding Loop Head, with a large second jib on, sprung her bowsprit in the heave of a heavy sea, and had to return. In November, 1823, both the "Arab" sloop of war and the "Big Jane" were lost in a heavy gale off the stags of Broadhaven.

It is not surprising, then, that the Reports of 1823 gave such a large increase from 1819, as to number in 1823, 27,142 vessels, and the men said to be engaged in the fisheries 49,448. The Act of 1824 reduced the tonnage bounty, and still further alterations of the laws were made in the year 1826, when the Act of 7 George IV. repealed all bounties to cease or expire on the 5th April, 1830. The speculating adventurers, who had principally provided large boats for claims of the bounty on tonnage, withdrew them from the fisheries, which left destitute a large number of men, and obliged them to seek other employments, while many emigrated, which relieved to some extent the distress that would have followed, though the latter were mostly land labourers; yet they had swelled the lists of fishery statistics.

At the end of 1829 the return of vessels showed the reduction to 12,611—the men numbering 63,421. The bounties that had been paid by the Government, distributed over a period of ten years, amounted to £151,390 4*s* 7*d.*; but, independent of that sum, loans and grants had been largely made to the fishermen, sanctioned by the 66th section of the 59th George III., c. 109, which kept on a body of fishermen, and greatly aided them in the building and repairing of boats, and providing gear. It is to be regretted that that fund was not continued, for it enabled the poorer fishermen still following the fisheries to keep their boats in repair. A building loan fund, as suggested by Mr. Barry in 1821, would have had beneficial effects.

From 1830 to 1846 but little dependence can be placed upon the official Reports of the actual state of the Irish fisheries. The seasons were favourable or unfavourable—supplies of fish appeared good, yet this was chiefly owing to the uncertain and limited means of transit. Still, the fisheries could not be considered in a healthy state, neither could dependence be placed on the statistics, which, in 1846, by the Nineteenth Report of the Board of Public Works, in which the return of the Inspectors of Fisheries is given, and which there states that the vessels numbered 19,883, and the men and boys 93,073. These vague statistics can easily be shown by the return made of native fishermen and boats near or within the range of Roundstone, county Galway, given in the Report for 1846, which states the numbers as 6,840 men and boys, and 1,530 boats of all classes.

The falsity of these kind of returns is strikingly exemplified by the evidence of Mr. Hart, of Clifden, county Galway, before the Select Committee of the House of Commons' Seacoast Fisheries (Ireland) Bill, 27th June, 1867, who, on the question of the coastguard officers' return

for 1865, which gave 379 vessels and 1,393 men employed on the coast from Mason Island to Ruana, states in reply, that "there is not a vessel at all upon that part of the coast fishing; in fact, that the returns were inaccurate, and that the people or fishermen had not recovered the effects of the famine to show such an increase as reported." From information recently received from the north of Ireland, every species of boat had been returned as engaged in the fisheries, though the chief occupation was the collecting of seaweed, sand, &c., and other purposes for land service. Such views may be adduced as general around most parts of the coasts of Ireland, especially the remote districts.

During the year 1844 an attempt was made by the Loyal National Repeal Association, of which the late Maurice O'Connell, M. P., was chairman, and a Report published in the month of September, to show the amazing advantages that would result in the encouragement and prosecution of the Irish sea fisheries, and gave statistics of their state at that time. The committee suggested that an educational training of the fishermen and their families should be adopted, and that proper investigations should be carried out for the better knowledge, improvement, and protection of the fisheries—in short, "such branches of knowledge placed within their reach as must conduce to render them at once skilful and hardy in their own calling, teach them to respect the rights and properties of others, and increase and preserve their own."

In 1830 and 1831 potato failure and cholera gave some stagnation to the fisheries, but they recovered to some extent, until the climax of evil came upon them in 1847 and 1848. In 1846 the sad approach to this evil had manifested itself in the total failure of the potato crop, when the dire distress—more especially among the coast population—strongly interested Sir Charles E. Trevelyan, then Assistant Secretary at the Treasury, to alleviate, as far as possible, such misery; and through his recommendation a grant of £5,000 was sanctioned by the Treasury, from the Governors of the "Irish Reproductive Loan Fund"—for the formation of curing stations on such parts of the coasts where destitution appeared the greatest among the fishermen. These were chosen in localities on the northern, western, and southern coasts; and curers were brought from Scotland to cure and to teach the system of curing fish. The stations, in several cases, were injudiciously selected. The Scotch curers, being only temporarily engaged, were indifferent (with the exception of Robert Brown, of Pittenweem) as to the success of their mission, or of the promotion of the Irish fisheries, and the fish in most instances were discreditably cured.

Roundstone, a station selected where such a large number of fishermen and boats had been returned, was obliged to be abandoned, and a subsequent Report of the fishery officials, mentioning this, states:—"Owing to the total apathy or inability of the inhabitants to avail themselves of its advantages." "In fact the soup kitchen had more

attractions than hazardous exertions on a dangerous and exposed coast, so that few attempts were made to supply fish to the station." They were not fishermen or sailors, as the return already quoted supposed them, but mere sod-men.

It has been recently stated that those curing stations, when so peremptorily abolished, paid 50 to 80 per cent. profit. This is one of the misrepresentations too frequently put forward as Irish grievances that cannot be maintained. On the contrary, unfortunately, they were wound up with loss, and with unfavourable results.* As I have already stated, several of the stations were injudiciously selected, to the exclusion of much more capable localities, and more favourably circumstanced for carrying out the intentions of Sir Charles Trevelyan—such as Dingle, where, as Mr. Donnell, Inspector of Harbours to the Commissioners of Irish Fisheries, reported—"The town contains a population of real fishermen exclusively employed in the fisheries."

At that period I visited the south-west of Ireland, and western parts, as I had for several years previously, exploring the coasts, and which made me well acquainted with the condition of the fisheries, and what would likely tend to their encouragement. In Killeany, Great Arran Isle, Galway Bay, there were twenty-five boats, of from ten to six tons, and fourteen canoes, manned by 150 men, who were all in the most miserable state, without clothes or food, and many able-bodied men had died of actual starvation, and such were the scenes in all parts of the islands. When, some years previously, I had explored Dingle Bay and the islands off that coast, I saw the capabilities of its fisheries, and how little the poor means of the fishermen had enabled them to turn to advantage. The numbers of able-bodied fishermen that were there, their sad state of destitution, and their utter incapability of benefiting to the extent their fisheries would yield to them, having only cumbersome open spritsail boats, which gave neither comfort nor protection at sea, led to the formation of the "Royal Irish Fisheries Company." The objects and likely results were so satisfactorily put forward, the project received the warmest support of the late Admiral Sir Thomas Ussher, the Marquis of Lansdowne, and Sir Charles Trevelyan—the latter I met in Dublin with Sir Randolph Routh. So favourably, indeed, I may say was it entertained, that a number of eminent men became Patrons and Directors of the Company, and, finally, through the kind recommendation of the Earl of Clarendon, then Lord Lieutenant of Ireland, and the Marquis of Lansdowne, President of Her Majesty's Privy Council, with the strong aid of Sir Charles Trevelyan of the Treasury, a Royal Charter of Incorporation was granted, by which the company assumed the title of the "Royal Irish Fisheries Company." So generously were the views entertained of benefiting the Irish

* The loss incurred in the attempt to establish these fish-curing stations, as per account rendered to the Commissioners of Audit, was £4,123 13*s.* 11*d.*

fisheries, that all expenses of the Charter were waived by the Treasury, with exception of fixed and permanent fees of office, whereby fully to the extent of nearly £900 was conceded; the eminent firm of Barrington and Jeffers gave the benefit of their extensive experience; and all would have progressed well, were it not for the unfortunate condition of the country, in which, as the famine panic became less, the insurrectionary and alarming state of Ireland precluded all possibility of seeking, or rather calling in shares.

It has already been stated in a variety of Reports that the operations of the Company were commenced at Dingle, where everything progressed most favourably with the peaceable and intelligent fishermen of that place, until disputes and contentions with regard to trawling arose. This was occasioned by a number of trawl boats going there from Dublin, with the avowed object of breaking up the Company. At that time but little was known of the character of the soundings of Dingle Bay; the valuable Admirality surveys, which have since completely worked out the whole coasts of Ireland, had not then attempted Dingle, consequently the entire of that bay had to be tested for trawling ground by the boats of the Company. When the invasion, I may call it, took place, only one small patch of clear ground had been traced; westerly of the Crow Rock, and extending westerly of Ventry Tower, with a stretch to the southward between those two points, of barely sufficient scope for four boats to work on—two belonging to the Company, and two native boats—consequently serious collisions occurred, and with the ever repeated clamour of the hook-men, destruction of spawn.

This gave the father of Irish Fishery Inspectors the opportunity of carrying out his long indulged and favourite hobby of boundary lines, thus continually fencing the bays from headland to headland around the coasts of Ireland. Through his investigations and Reports two-thirds of the Bay of Dingle were cut off against trawling and all further enterprise.

This prohibition induced boats to be sent to Galway, where a greater range of bay was open outside the boundary line than what Dingle could at that time give. Here again clamours, which were encouraged, arose against the boats; all kinds of spawn and small fry were sworn by the hook-men to be destroyed. Numerous are the instances I could adduce, and specimens exhibit, of the absurdities of such views, and the manner the inquiries were entertained; but I will confine myself to one, Galway Bay, which may answer for all. I mention this the more particularly as the evidence given before the Committee of the House of Commons, Select Committee Sea Coast Fisheries (Ireland) Bill, 28th June, 1867, of the remarkable intelligence of Mr. O'Flaherty of the coastguard, and the strong impression made upon the minds of the fishery officials as to the small fish and spawn destroyed. Mr. O'Flaherty's Report was published in the Report of the Commissioners of Fisheries for 1852. Now, what were Mr. O'Flaherty's pretensions to such knowledge, or arriving at such, or claim to such intelligence?

Mr. O'Flaherty states that he was out in the trawling cutter "Druid" eight days during the month of July, 1852, in Galway Bay, in which return he gives the fish taken and the quantities of small fish destroyed. He bottled up the slime from the fish off the deck as spawn. I was in Galway. In the first place, according to the declaration of the master of the "Druid," the intelligent Mr. O'Flaherty was only out three days, and he took the returns from the master of the "Druid" of the fish taken on other days. I was on board the "Druid" in a stiff breeze, and great swell in the bay off Black-Head. Mr. O'Flaherty was comfortably ashore. The fish taken were a large quantity of fine turbot, soles, brill, plaice, small dabs, gurnard, and hake. No small fish were taken of any of the kinds named; and Mr. O'Flaherty and the supporters of his views may be informed that no spawn of fish will be met with in July, at least of our white or round fish, and of turbot and soles, the spawning time being past.

Exhibited are instances of the ova of *Purpura lapillus*,* *Ascidia*† *virginea*, molluscs, which were averred to be spawn of fish, and ova from the Frith of Forth, stated to be the ova of the herring dredged in moderately deep water. This I cannot conceive to be other than the spawn of some of our pleuronectidæ. Herrings do not spawn in deep water. In such bays and inlets as Smerwick, Ventry, and Sneem, at extreme low tides in water pools and gulleys of those shores will be found myriads of the fry of the herring and the pilchard in the month of July; and they remain in the shoaler parts, until they attain a size to go into deep water.

Scientific men have even volunteered evidence somewhat surprising. However, no practical knowledge seems to have been brought to bear. Professor Van Beneden, a great author on some subjects, mentions that Norwegian Naturalists, who have been inquiring into this question, have reason to believe that the ova of the cod float about on the sea, and are hatched there; and others, following such notions, state that they have captured the ova in a towing net; but none of these men of science ever saw the fry exude from the ova, or were satisfied that such ova were in a healthy or advanced stage of development to detect it to be the ova of cod. The ova of cod, haddock, ling, and hake, and even of herrings, will not float when in a healthy state of impregnation. The specific gravity will always cause the ova to sink, and remain undisturbed in such localities of the coast where instinct influences the fish to congregate and deposit the ova; hence it is, in certain seasons of the year, that these fish approach shoaler soundings for the deposit of ova. You will never meet fish in deep water soundings with ova developed; for thus in the winter months cod-fish are taken nearer the coast, and are sold in our markets full of pea, at the time they are most

---

* This species of mollusc is very destructive to mussel beds.

† *Ascidia opalina* of Macgillivray, taken in 20 fathoms.

out of season. The finest condition of the cod and ling is throughout the summer months, taken in deep water, at a distance from the land. They are then in the best state both for the table and for curing. It is not right, without practical knowledge, to attempt to disprove views the results of practical experience. Off the coasts of Labrador and Newfoundland the finest codfish are taken. In the spring months, when, and after spawning, they are taken on the inner or shoaler banks; they after, to recover, retreat into deeper water, where the greater quantity, and finest condition of the cod, are met on the Great Bank in forty-five to sixty fathoms during the summer months. The withdrawal of encouragement to the British fisherman has resulted, by State support given by the French and Americans, to throw the whole advantages of those fisheries into the hands of the fishermen of those countries, while the poor British sailor has to content himself in smaller craft to an inshore fishery. In fact, Great Britain has yielded the interests of those fisheries, which were the pride of former reigns.

To return again to the "Royal Irish Fisheries Company," which had been working most successfully at Dingle for some years, it was thought desirable, as the project had been so completely tested and proved, to place it again before the public. A difficulty occurred with regard to the validity of the Charter, as there was a provision that, within a given time from the date of the Charter, a deed of settlement should be executed, and a copy thereof deposited, with a statement of amount of capital and shares, with the Board of Trade. It has been stated the causes which prevented compliance with this provision of the Charter, which the experience of the Messrs. Barrington led them to believe would, from the circumstances, be of no moment. The Right Hon. Edward Cardwell, then President of the Board of Trade, who was generally adverse to chartered companies, thought otherwise, and would not consent to a Supplemental Charter, though recommended by the Marquis of Lansdowne, and Lord Granville, President of the Privy Council—the Royal Charter, as Lord Lansdowne observed, being granted by the Queen in Privy Council, under the Great Seal, was, though not legally valid, only in abeyance. Mr. Cardwell was desirous that his principle of a Limited Liability Act should alone be entertained.

From the time it was decided that a renewal or supplemental Charter could not be assented to, the Directors declined further to prosecute the fisheries with the views advocated by Mr. Cardwell; and thus terminated an undertaking that promised to be most flourishing, and of great benefit to the fisheries of the country. The Company then passed into other hands, who, unauthorised, traded in the name of the "Royal Irish Fisheries Company," broke up the establishment at Dingle, where its working had been favourably progressing, commenced a silly expenditure at Galway, with an utter ignorance of the fisheries, which resulted in total failure. This system of management may be generally

applied to all companies where the necessary knowledge was not with those who exercised—or rather endeavoured to exercise—control in the management they had undertaken. The late Mr. John Good, well known as a thoroughly practical man, and proprietor of the finest trawl-boats on the east coast, when giving a Paper, "Notes on Trawling on the East Coast," remarked on the management of the Royal Irish Fisheries Company at Dingle:—"Mr. Andrews' labours were completely successful at Dingle up to the time of the project assuming another directory." No shares were called in, nor obtained, by the Directors of the original project. The subscriptions were voluntary for the payment of fees of Charter, preliminary expenses, and commencing operations, and with loans obtained through the "Society for Bettering the Condition of the Poor of Ireland," successfully maintained its working at Dingle, and realised good value both in stock and plant. It should be mentioned that, through the generous interference of Sir Charles Trevelyan, the large stock of salt and plant at Valencia were handed over to the Company at Dingle.

This state of the fisheries leads to the notice of the "Society for Bettering the Condition of the Poor of Ireland," which now may be justly termed the "Forlorn Hope of the Irish Fisheries." In the first part of this Paper I have alluded to the Report of the trustees of that Society for the past year, just published. It will be there seen the system of proceedings, and the amount of good effected around a great extent of the coasts of Ireland. The loans to fishermen, who are well recommended, and with approved securities, are granted by the Society free of interest, in sums from £10 to £500, repayable by easy instalments, extending over a period of from three to four years. The localities where the loans have been distributed are marked on the chart now exhibited. Of loans made by the Society, £10,796 6*s*. 1*d*. remain outstanding to 31st December, 1872, and which may probably be increased £3000 to £4000 more before the instalments repayable in May next are received, May and November being the periods for the repayments. Few losses have occurred, and those but small proportions of outstanding instalments, arising from death or other uncontrollable causes.

I am proud here of the opportunity of recording the very high opinion entertained by the Trustees of the Honorary Secretary, George Kinahan, Esq., of Roebuck Park, whose unwearied zeal in the cause of charity, and thorough business habits, and financial intelligence, have carried out most successfully the minute and responsible labours of the monetary transactions of the Society from the date of his undertaking the office, the 5th June, 1861, which the elaborate accounts of the Society will amply testify.

The subject of loans adverted to in the Report referred to for 1872, is one of considerable difficulty, requiring much judgment as to propriety of allocation, and of safety and utility in distribution to applicants. Hitherto, through other channels, uncertainty of beneficial

results and losses have occurred, and recommendations have generally tended as to doubtful advisability of such encouragement. In the management two very important points must be considered. First, the employment given to industrious fishermen, who are really occupied in fishing, and which would promote greater supplies throughout the country. Secondly, that such encouragement would, by forming a body of seamen, be of importance when necessity required their services. It has been suggested that such ends could be accomplished through the coast-guard, and that that service could greatly aid in the distribution and application of loans to the fishermen. Now, the nature of the coasts of Ireland and position of the fishermen are to be viewed. On many ranges of the coasts there are extents of wild and rocky shores, where there are neither shelter for fishing craft nor any resident proprietary that could encourage any system among the men, who are more a class of small farmers than fishermen, and who only in their shore boats take advantage of any fine weather when fish approach their localities. Though poverty may be great among them, they have no countenance, through absent owners of the soil, and even were security to be obtained by them, the loans would more likely be employed to the advantage of their little holdings than to the procuring of means for pursuing fishing.

Still there are many that demand our greatest sympathy—those (and there are districts that I could name) where the fishermen are detached in isolated places, whose only means of existence for themselves and families depend on their daily labour on a wild coast. These poor men have no holdings—no spot of land but that on which their cabins stand—yet with their corrachs they are daring and industrious. The question arises where are the securities for loans to such? The holders of land around their dwellings will not be; and they are unknown to the absentee proprietor. Can Government be called upon to subsidise these poor people, who are dragging out a miserable existence, but whose numbers emigration is fast thinning? During the sad times of 1846 Mr. Bertolacci, in writing to Mr. Leake, one of the official trustees of the Irish Reproductive Loan Fund,* on the application of

* The Irish Reproductive Loan Fund appears to have been formed from a balance in the hands of a Committee of contributors to a subscription, which had been raised for the relief of urgent distress in Ireland in 1822. Her Majesty granted a Charter, dated 4th June, 1844, to the Irish Reproductive Loan Institution: the Charter placed in the hands of Governors named therein a further sum of £45,000, and its accumulations, being also part of the balance of the above subscription, to be employed in loans to the industrious classes in the provinces of Munster and Connaught, of small sums of money, implements of labour, seed, and other raw materials, to be employed in husbandry, trade, or fisheries. The Trustees in Ireland were to allocate the money, and so rigid were the rules with regard to the repayment of those loans, that the Trustees were called upon to make good the outstanding loans, which were not recoverable owing to the distress occasioned by the famine years of 1846, 1847, and were it not for the determined line in their defence made by Lord Lucan (who was one of the Governors) the Trustees would have been made accountable. A balance of that fund and its accumulations still exists, vide Act 11 & 12, Victoria, ch. 115, s. 14.

money in loans to fishermen, says—"It is the most difficult part of my duty to report upon. All the shallow-water fishermen, and in some instances the deep-sea fishermen (where they are to be met with), are not (as on the English coast) solely fishermen, but as much potato-growers, remaining idle except when the fish actually comes into the harbours."

"As to the plans suggested by Sir James Dombrain and Mr. Barry, of lending money through the coastguard [continues Mr. Bertolacci], I cannot, nor would you were you to see this country along the coast, look upon it in any other light than as a theory, which practically could not be carried out, and I fear the funds would soon be returned as irrecoverable."*

Lord St. Lawrence, Member for Galway, who gave much attention with the desire of promoting the fisheries of that bay, found many difficulties in the way which opposed and impeded his good views. Three very able and clever letters from his lordship appeared in the "*Daily Express*" of the 1st and 16th of August, and 10th of September, 1867, when the subject of the Irish fisheries was much agitated. The absurdity of encouragement to these small farmers, as fishermen, was sensibly viewed. To sum up the inconsistency, every project was suggested for the promotion of the fisheries of Galway, and pecuniary aid tendered; but no security was forthcoming, and in the very best and most profitable season of the year, these so-called fishermen abandoned the fishing, and turned solely to seaweed cutting for the culture of the land.

The coastguard, or waterguard of former years, were of a different class of service to the present men. They were resident more amongst the people, and their stations were remote or detached. Many stations were in districts of a rocky coast of great extent, and I have admired in isolated positions the respectability and neatness of the men, and their families, which strangely contrasted with the wildness and misery of the country around. Most of these out-stations have been withdrawn, and more centralised, and new regulations under the Admiralty have established a fine reserve of seamen for the service of the Royal Navy.

The subject of loans was discussed before the Select Committee of the House of Commons on the taxation of Ireland in 1865, as to what had been, or could be, done to promote the Irish sea fisheries by Imperial legislation. Of this Committee General Dunne was chairman, whose indomitable labours to sift the evils by which Ireland appeared to suffer must be gratefully remembered. He endeavoured to trace what grants from the Treasury had been given

* *Vide* Correspondence from July, 1846, to January, 1847, for the relief of the distress in Ireland and Scotland. Fisheries series (1847), page 18. The circumstances of the present time (1873) are similar.

in aid of that branch of industry. The little at the time that could be done for Ireland in the assistance to poor fishermen rested with the "Society for Bettering the Condition of the Poor of Ireland," whose funds it is seen have been unreservedly exercised in furtherance of that good object. Still every available hope was looked to, which led to the evidence that an annual grant of £5000 was supposed to be in abeyance since the year 1830, being a grant sanctioned to Ireland by the 66th section of the Act of 59th George III., cap. 109 (12th July, 1819), continued to be held in force, made from the Consolidated Fund, under the 5th George IV., cap. 64 (17th June, 1824); and, again, the quoted Acts appeared to be maintained by 5th and 6th Victoria, cap. 106 (10th August, 1842), which enacts, by section 1:—"Provided always that nothing herein contained shall be construed to repeal any enactments or provisions of said Acts, or any of them which relates to piers or quays, or assisting poor fishermen, or any powers in respect thereof, now vested in the Commissioners of Public Works (Ireland), or any moneys applicable to such purposes in the hands of the Commissioners of Public Works; but all such enactments and provisions relating to piers or quays, or assistance of poor fishermen, and all such powers in respect thereof, or of the application of moneys applicable to such purposes, shall remain in full force and effect." Now, it was presumed that that section of the Act continued in force the 5th George IV., cap. 64, which in the same section of that Act gave to Scotland the annual grant of £3000, and which to the present has been charged each year as a Parliamentary grant by Scotland, under the 5th George IV., cap. 64, in "General Account for Piers or Quays." These views with regard to Ireland were warmly supported by the late Robert Longfield, Q. C., Member for Mallow (author of "The Fishery Laws of Ireland," 1863), and by Sir Edward Grogan, who were both on the Committee, and by the late Lord Chief Justice of Appeal, the Right Hon. Francis Blackburne. Others maintained that £13,000, granted by 1st William IV., cap. 54 (16th July, 1830), rescinded the grant of £5000 to Ireland; but it would appear that the £13,000 was sanctioned for the completion of fishery piers undertaken by the Commisioners of Fisheries previous to 1830. From 1830 the sum of £13,000 was to be disbursed in payments extending over five years, the annual sum each year decreasing until the fifth year, when £1000 would only remain to be paid; yet, at the termination of the fifth year, the close of 1835, an unexpended balance of nearly £12,000 of pier and loan funds appeared to be in the hands of the Board of Works.* The Act of 1842 (5 & 6 Vict., c. 106, sec. 1), certainly states—"*Now vested* in the Commissioners of Public Works, applicable to piers or quays, or to

* Appendix to the First Report of the Commissioners of the Irish Fishery Inquiry (1836), pages 30 and 31.

poor fishermen." Chief Justice Blackburne expressed (2nd December, 1865)—"The exclusion from the repealing Act of any enactments relating to piers, &c., vested in the Commissioners of Public Works, or any moneys in their hands applicable to such, would seem to have two distinct purposes. First, the preservation and retention of all enactments relating to piers, &c. Now, could there be any end or object in saving and perpetuating these powers, if the £5000, the means of executing them, were withdrawn? It seems to me that the perpetuation of these powers necessarily required that of the grant of £5000, without which they would be simply abortive. The second purpose is simple, that of fixing with the trust, and for the continuing purpose of the Act, the funds already drawn by and in the hands of the Commissioners. It would seem to be a violent and arbitrary extension of these words to hold that the Commissioners were to have no other means of executing the important trusts confided to them, and which were perpetual, than the balance of the fund that might have been in their hands when the Act was passed. The result seems plainly to be that the trust and means of executing it were to remain vested in the Commissioners." The opinions of the law officers of the Crown were adverse, and therefore expectation rested.*

Fault appears to have been for not at the time persevering in seeking for Ireland the continuance of that grant of £5000, while, under the same Act, Scotland still receives her £3000; and which was, as the Hon. B. F. Primrose, Secretary to the Scotch Fishery Board, stated to the Select Committee of Seacost Fisheries (Ireland) Bill, confirmed by that Act, which gave the £5000 to Ireland:—"That Act passed in 1824; but (Mr. Primrose continued) we never got our money till 1828, and on asking for the amount which was due between 1824 and 1828, it was refused, because they said that we ought to have asked for it; so we lost four years' money by not asking;" and Ireland lost £5000 a-year by not asking!!!

Mr. Brady, inspector of fisheries, whose long connexion with the fisheries of Ireland and their official details, gave foundation of authority, stated before the same Committee, 3rd July, 1867, with regard to the portion of £5,000, £500 a-year to poor fishermen—"I think that sum has been available under the Statute since 1830, but it has not been claimed. There is nothing, in my mind, which repealed that provision of 5th Geo. IV., c. 64." Mr. Primrose further states, "that £500 a-year allocated to boats of poor fishermen (and which was applied in that way from 1828 to 1850) was given up upon his representation, as it was found to work so ill, and the entire grant taken for piers and

* The opinion of the Attorney and Solicitor-General of England was—"The original grant of £5000 a-year is not now in force, or capable of effect." Mr. Justice Blackburne, of the English Bench, expressed in a recent case—"He could not say the case was clear, for it turned on the construction of Acts of Parliament, and therefore nothing in it could be clear." (January, 1873, Court of Queen's Bench.)

harbours." It is not explained upon what principle a provision of an Act of Parliament could have been so dealt with, or differently applied.

We have been taunted with having received large grants to the extent of £90,000 for the improvement of the fisheries. Those sums were supposed to be given in consequence of the great distress occasioned by the potato failure in 1846, for in that year the Act 9th Victoria, c. 3, was passed for the object of employing the people, which allocated £50,000 for the encouragement of the sea fisheries, and as a source of employment and food, partly to be expended by way of loan, and partly by way of grant, in the construction of piers and harbours, and other works, on conditions and restrictions specified in the Act. In the following year a further sum of £40,000 was granted by Act 10 and 11 Victoria, c. 75, for similar objects and on similar conditions. The money was not to any extent applied for fishery objects or for employment of the fishermen, for no advances were made for boats, tackle, or other necessaries for fishing, but for piers and harbours, which were equally constructed for commercial purposes, and for which repayments were levied on the districts and by contributions. Though ostensibly voted for immediate relief in the famine years, yet by way of grant £74,700 had only been expended, spreading over a period of eighteen years.

In any statements I have given, I wish it to be understood that I make no reflections on the Commissioners of Public Works, for whom I have great respect, as I am well aware of the stringencies of the Acts which controlled their public duties.

The next to be considered are the fishermen and the fisheries, and the most useful means of aiding and promoting them. I have stated that there are many returned as engaged in the fisheries of Ireland that have but small means of carrying them out, or that only turn their attention occasionally to such pursuits, being occupiers of small holdings or engaged in farming work. Are these, then, well-founded claimants for Government aid? Certainly not. The owners of the lands which they occupy or the absentee proprietor of the soil should see that they had that encouragement in their several tenures which would ensure comfortable existence for their toil. Those that demand our greatest sympathy are the poor corrach-men, who labour on the wild and rocky shores of an exposed coast, yet are daring and industrious for the support of their families. They have no holdings save their little cabins, and occasionally a little plot of ground on the con-acre system, for which they are charged unreasonably high. Their inshore work cannot treat them as deep sea fishermen; yet if they were near established stations, where employment could be given, they would be energetic and useful as fishermen, and eventually as seamen. It would be desirable, as expressed by an intelligent English naval officer who had served on the coasts of Ireland, "If the fishermen were congregated into villages, and separated from farming pursuits, and the farmer

to employ himself in tillage instead of fishing, it would benefit both parties." This will lead to the main point—the formation and true promotion of our fisheries—viz., the establishment of proper stations on those parts of the coasts where a general fishery can be successfully carried on throughout the seasons, and where there are such localities that would give shelter to a class of large sea-going boats, being the only means of turning largely and profitably to account our prolific fisheries, and of the formation of seamen, who should mainly depend upon such resources for employment. We must not at first rush too extensively into such a project; therefore the selection of a few points illustrating their capabilities may for the present suffice.

The stations to be selected would be Killybegs, Galway, Dingle, and Bantry. Of each I will explain in a general way their resources, and their connexion with important fishing localities. First, Killybegs. The harbour is well sheltered, and has a good depth of water. It is the safest and most commanding position on that part of the north-west coast, and where a station could be most successfully maintained. The enormous quantities of herrings that were formerly taken by the Killybegs, Inver Bay, Teelin, Kilcar, and Malinbeg boats, are supposed to have decreased; but it is not so—they are equally abundant, both the winter and harvest herrings. The large and safe boats, with deep and long trains of nets, both for the herring fishery and for mackerel, are wanting, for it is upon the early fishing of the season and in deep water that will chiefly depend success.

This is the case in all the bays or localities of the coast that I may refer to. Donegal Bay can be well worked throughout the winter season with good boats, as the stream of flood in the bay is scarcely perceptible. Cod fish, ling, hake, pollock, coal fish, are abundant, and would, with the herring, give large supplies for well-regulated curing-houses. Throughout the summer the fishery may be extended to a more distant range, as well for herrings and mackerel as for cod and ling, which are abundant off Tory Island, and large quantities may be taken from Teeling to Malin Head. Sheephaven may offer temporary shelter to run from Tory Island grounds, where there are fine turbot, and cod and ling.

In speaking of fishing grounds, which are erroneously termed banks, as they are mere variations of soundings, there are continuous ranges along the entire of the north-western, western, and south-western coasts—many of them known to the local fishermen, yet few can tell their true compass bearings. These soundings vary at distances from the land, the depth generally from 35 to 60 and 80 fathoms. The recent Admiralty surveys have so accurately marked the fathoms of soundings and generally the character of bottom, that no difficulty can exist in making out the best grounds. A small dredge, with proper lead lines, will easily determine the nature of the soundings, proving the marine animals, the sandy, shelly, shingly, or other characteristics, which will at once decide the most likely grounds of resort of cod, ling, tusk, haddock, conger, and turbot.

At Galway, where such facilities of transit are at present, a fine fishing establishment could be formed. Off the Arran Isles and Greatman's Bay, on the Connemara coast, the winter herrings are abundant. Greatman's Bay would give shelter to large boats, as the holding ground is good. The mackerel and herring fishing of May would prove, with able boats and proper nets, most successful, long before any attempts are made to take them in Galway Bay, eastward of Blackhead. Stations at Arran and at Innisbofin Island, where the latter has good shelter, and sufficient depth of water, in Bofin Harbour, would give great advantages during the summer months. Herrings are plentiful. Turbot could be taken, and ling and cod off Achill. Off the Inniskea Islands, and N. W. of Innisbofin, and with a fine range extending to Slyne Head, where the Mark-na-Geeragh fishing grounds have plenty of ling, cod, and turbot. To be successful, the boats must be able and decked, with great extent of long lines, and with sunfish gear; for it is in that range those sharks appear, at the latter end of April and beginning of May, when their capture is easy.

Dingle would also yield abundant supplies. The grounds off the Islands N. W. of the Blaskets, and N. W. of the Great Skellig have abundance of fine ling, cod, tusk, hake, and conger, and splendid turbot inside the Great Skellig, and to the south of the Great Blasket. S. W. of the West Blasket, in fifty and sixty fathoms, large haddock are taken. Portmagee, Valentia Island, in connexion with Dingle, would yield great returns, as there are fine fishing grounds that have been tested from Bray Head to Puffin Island, and between the Little Skellig and the Lemon Rock. A valuable and productive herring and mackerel fishery in early summer is lost to the Dingle men for want of good luggers and long and deep trains of nets. Although a most extensive curing establishment could be formed there for the cure of ling, cod, and hake, as well as herrings, which they fully understand, yet their means being limited, they prefer trawling, which brings them, by the sale of fresh fish, prompt market returns. They do not cure any of the better kinds of round fish but hake, which are taken in abundance with hand-lines during the autumn after the trawling is over.

Bantry, and Berehaven, would be other effective positions, herring fishing and a general fishery being productive there. There are also other resources, such as seining for mackerel, mullet, scad, and pilchards, and lobster fishing early in the season would be remunerative; but lobsters are on more distant ground then, before the ova or coral, as it is called, are matured; they then are more plentiful near our rocky shores. There can be no hesitation in asserting but that a general fishery throughout the seasons can be established, and great stocks of cured fish could be realised, which would secure demand in this country, to the exclusion of the very large imports yearly made of Shetland, Scotland, and Norway cured fish; and which imports have been stated as reaching £100,000 a year.

Though numerically the fisheries would appear to have declined by

the lesser returns of boats and men, yet the superior tonnage that are now in use along the entire range of the east coast, and at Kinsale and Dingle, must be considered, while the increasing exports of fresh fish to the English markets of turbot, soles, mackerel, and herrings, will go far to prove that the fisheries have not degenerated. Judge what Howth, Skerries, Balbriggan, Kinsale and Dingle, were some few years since, and see what they now present during a fishing season, and which would still further advance had they on the east coast safer shelter, and improved harbour accommodation.

An important feature must not be overlooked—our home market. Better regulations are much needed, and that market monopoly of the factors differently carried out. Until some interference for better control is exercised, the citizens of Dublin will never be supplied with the choicer kinds of fish at reasonable rates, nor the industrious fisherman properly remunerated for his hard-earned toil. The ready transit of fish should have accomplished more favourable returns to our coast fisheries.

To sum up what I have given in a general way, the fisheries of Ireland present a fine field of enterprise and profit, and in every sense of considerable importance—of enterprise and profit to those who can, with knowledge and prudence, grapple with the undertaking; and of importance, by ensuring greater supplies throughout the country, and which must also result by constituting skilful fishermen and good seamen. This, as I have observed, must mainly depend upon the separation of farming and fishing interests, for serious calculation must be made of the great want of field labour. The population, according to Mr. Dennehy, has during the past twenty-five years decreased 3,000,000 (63,995 Irish, by the New York immigration returns, having arrived there during the year 1872), and tillage crops have decreased the last twenty years 1,000,000 of acres. It is now easily seen why our local markets are so badly supplied, and provisions so exorbitantly high, for it was our small farmers of twenty to thirty acres (Irish measure) that kept up our stock of cattle (especially horses), pigs, &c. At the same time, there can be no doubt but that Ireland has materially advanced in improved breeds of stock, and in better means of agricultural pursuits (for which much is due to the Royal Dublin Society); but that stock has not increased in quantity, though it may in quality, and of which the greater share passes from us to the markets of England.

In conclusion, a very serious consideration for the better and more certain improvement of our fisheries presents itself. You, Sir (addressing the chairman), must be sensible of the importance of the suggestions that I now venture to make. In the army and navy, in the staff, control, and civil services, in all branches of scientific professions, and in some of our leading banks, competitive examinations for the several branches of such services are necessary, and as each grade or step of promotion advances, the examinations in most cases necessarily become more

extensive and more stringent. The Right Hon. Edward Cardwell, in an admirable speech, recently made at Oxford, expressed, "under the arrangements for the localisation of the army, provision would be made for the training not only of the privates, but of the officers." Then, Sir, is it not important that a training should be exercised with those that are advanced to a control in a public department, as that of our fisheries, and to which department the Acts of Parliament of 1869* have given such imperative powers, over a branch of our national resources, which have so often been adverted to as a main feature of the country? Would it not be right then that in all future nominations a training for examinations should be exercised before appointments could be confirmed, and that merit alone should have the advantage? for if by those in authority rules and decisions be not framed and grounded upon scientific and practical knowledge, it will be vain to establish respect for the laws, or with the fishermen confidence in their control. The study of ichthyology, marine zoology, and animal physiology, should be made a scientific and practical course. The seasons and habits of fish, topography of our coasts, use and construction of charts, tides, and winds, should all form essential points to be thoroughly informed upon. As illustrative —in one of the early Reports an Inspector of Fisheries states, that "the harbour of Roscarbery is remarkable for large quantities of sand eels, a small fish somewhat resembling sprats"—fish of totally different generic characters and habits. In a prosecution for protection of valuable eel fisheries in the Shannon, where quantities of eel fry had been destroyed, a clever attorney so puzzled the evidence, and those that presided at the inquiry, that no one could prove that they were really eel fry. I will give one more instance—an extract from a letter of an Inspector of Fisheries, addressed to a fishery official in Norway, published in the Report of the Deep Sea and Coast Fishery Commissioners for 1865: "You know how deplorably ignorant we are upon many important points which are unsettled subjects of contention between the different classes of fishermen, and how very important it would be to be furnished with such practical information as should enable us to test, by the experience of other countries, the effects of those modes of fishing complained of here as over-exhaustive." "It is at length admitted that there is no possible reason why what we call seafish should not require, like salmon, a period of rest for reproduction and recovery."

I will wind up with a quotation from the "*Times*" of the 3rd of January last :—"We should like to see the Irish developing their splendid fisheries, and for our own sakes, no less than theirs. We wish every Irish railway paid as good a dividend as our best trunk lines. If Irish bogs can really be made to yield a cheap substitute for coals, that event would be among the most welcome of the year 1873. If such things can

---

* 32nd Victoria, Salmon Fisheries (Ireland), ch. 9, 13th May, 1869; 32 & 33 Victoria, Fisheries (Ireland), ch. 92, 9th August, 1869.

be done, and are not done, the fault will not be ours. The legislation of a hundred years since will not be repeated in these days. Ireland will have fair play, not to say more, and it rests with herself to turn to good and permanent purpose such opportunities as she is now obviously enjoying."

The Chairman (J. Pim, Esq., M. P.) said the subject was one of great interest, and there were, no doubt, some gentlemen present who wished to give them the benefit of the information they possessed on it. In some counties he was acquainted with, the farmers were successful in getting herrings, in some instances to an extent that went a long way towards paying the rent. He thought there was a better chance now of employing fishermen to catch fish all the year round than formerly, because there is a certainty of a market, whilst many years ago fish were sometimes useless, and made into manure. He wished to ask, what was the present opinion in regard to trawling. In '48 a friend of his own was anxious to try trawling in Galway Bay, under the belief that it would be an improvement, but the people were very averse to it, in the belief that it would destroy the spawn. He wished to know was trawling as now practised in Galway paying, and what was the effect of it on the supply of fish?

Mr. Brady, one of the Inspectors of Irish Fisheries, said that the question of trawling had occupied his attention for more than twenty years. He was the first person to recommend the Board of Works to repeal the by-laws against trawling in Dingle Bay. He had a strong opinion with regard to free trade in fishing, but lately in Galway they had had a repetition of outrages by Claddagh men against the trawlers, and two boats had been set on fire. He had investigated the matter, and several Claddagh men were sent for trial. The evidence given at this inquiry was, like all such evidence, very contradictory: every one gave evidence according to his bias, and no one knew better the danger of relying upon such evidence than Mr. Andrews. He decided that a series of experiments should be carried out, not like those of Mr. Fletchley, but every month in the year, every available day in the month, and every available hour in the day. He trusted these experiments would result in something practically useful. So far as taking up the spawn was concerned, he thought the allegations on this point were without foundation. The only question was, did the trawlers destroy any considerable quantity of small, unmarketable fish? If it turned out that on no day of the month did this destruction take place, he thought it would be the strongest evidence to induce them to repeal all existing by-laws on the subject of trawling. He regretted that the members of Parliament who endeavoured to repeal these by-laws were not successful, and that they did not get the support which was necessary. However they hoped to have at the end of the year such information as would enable them to give decided information on this point, particularly in regard to the question of taking the small fish. He agreed with Mr. Andrews on every other point. He believed the Society was indebted to Mr. Andrews for rbinging the subject before it. There was hardly any question relating to the resources of Ireland that was of more importance than the development of her fisheries. Ireland was selected as the fish-producing country, and the more facilities for piers and harbours of refuge the better. He was happy to say that this year the sea fisheries in Donegal Bay had been such as exceeded in extent the memory of the oldest man. But, as a rule, from the want of means, the poorer classes of fishermen were unable to capture the fish as plentifully as they otherwise might. In several places there were no herring-nets although plenty of herrings. In Killybegs, for instance, there was not a single herring-net. Loans administered judiciously was the only possible way of improving the coast fisheries of Ireland. Though Government had given them great powers, they had not given them an annual grant for the promotion of fisheries in Ireland. They should, therefore, do the best they could by avoiding throwing impediments in the way of fishing. He thought at one time there was about £5,000 a-year due to them for forty years for the promotion of the coast fisheries, but he had looked through the matter, by the aid of the law officers of the Crown, and he had

found that that was not the case, and that an Act of Parliament had decided, and that they had lost their money. It was an extraordinary fact that public fishing companies in Ireland had hitherto failed, and he was afraid that such companies would fail in the future. He would be sorry to damp the ardour of capitalists, if he thought their work would do good. Mr. Andrews attributed the failure of the Royal Irish Fisheries Company to the loss of the Charter. He (Mr. Brady) was at a loss to understand why the seal of her Majesty would improve a private enterprise. Perhaps Mr. Andrews would tell them how the abeyance of the Charter prevented the company working. If the company were established on sound principles, and were doing a good business, what did they care about a royal charter? If it could be shown that a royal charter would benefit the fisheries of Ireland, he would be most ready and willing to promote the application to the Queen to grant one for a company, but he thought the fisheries of Ireland should be developed in some other way.

Mr. John Adair thought there was no ground to look forward to failure in future enterprises, because we had failed in former ones.

Mr. Montgomery said there had been only two companies in latter years that had not succeeded. One was the Irish Sea Fishing Company, that spent too much money in boats and buildings, and the South of Ireland Fishery Company, that, out of a capital of £10,000 were paying £1,000 a-year in rents and salaries.

Mr. Blake said, with reference to the profits on curing establishments, 50 per cent. would not be too large a sum, and the society with which Mr. Andrews was connected was a good illustration of what might be done by careful management. When the ordinary fisherman made 25 yer cent. beyond his outlay, he should make an equal sum to support himself, and that would be 50 per cent., about the same amount these curing-houses were realising. Mr. Andrews spoke of the ova of the cod sinking, and perhaps he would lead the meeting to imagine it was a general rule that it sank. But according to the opinion of Dr. Sars, the great Norwegian naturalist, it deposited its spawn on the sea. This naturalist found the ova floating on the ocean, and he believed it was intended that it should so float, as there was attached to the ends of it a small quantity of oil, which, being lighter than the water, showed that it was intended the ova should float. Therefore the trawl could do no harm: with the best trawl they could never take the ova from the bottom of the ocean, but they could get it in the ocean. He (Mr. Blake) believed that as a general rule trawling did no harm, for even when the fish do spawn in the bed of the ocean, they select places which cannot be touched by the trawl. He believed Mr. Brady's experiments had not resulted in taking up spawn from Galway Bay. Mr. Andrews had asked, were the men who combined farming with fishing the men the Government should subsidise. He dissented from Mr. Andrews, when he said that half fishermen and half farmers never could effect anything. He believed the fisheries of Ireland would never be carried on successfully except by the half farmers and the half fishermen. There was no industry that required more the supervision of the people engaged in it than fishing. Every spare moment should be looked after, and the greatest industry observed to get the fish to market. When they came, in the matter of companies, to pay a chairman, directors, and secretaries, who had no knowledge of the subject, and managers on the spot, and the men who draw their incomes from the company, in every instance the plan would be a failure. Ireland being the most tempestuous country on the face of the earth, in many places for six weeks at a time the boats could not go to sea, and the men became disorganised and demoralised in the public-houses. The result was they could not be got to go to sea when wanted. Therefore the coast should be fished by half fishermen and half farmers, or not at all. These men could spend profitably the time when fishing was impracticable, on the land. Wherever fishing only was carried on, the place had become impoverished, and of this assertion he gave several proofs. It was his opinion that five times as much money as had been mentioned by Mr. Andrews could be profitably expended in loans. There would be a stronger argument in favour of Government loans, than the good Mr. Andrews' society had effected. He believed the country was very much indebted to Mr. Andrews for the zeal he had shown in the promotion of fisheries and the knowledge and enlightened views he had displayed on the subject.

In reply, Mr. Andrews was glad to learn from Mr. Brady, Inspector of Fisheries, that experiments, repeated throughout the seasons of the year, on all available days, were to be carried out, in order that it might be satisfactorily tested whether or not, by any system of fishing, injury was done to the spawn of fish, or the fry. It has been stated that spawn could not be disturbed by trawl-boats, or that proof of destruction had ever been established to that effect. With regard to fry, the regular trawl-boats engaged in that mode of fishing do not trawl in the shallow soundings, where fry resort during their early stage of growth; the injury would more likely be caused by the pole, or in-shore drag-net boats. Mr. Andrews had already explained why the Royal Irish Fisheries Company had not continued, though its success, and the principles of its working were well established. No company can ever succeed, or maintain its expenditure, unless the nature of the coasts, and the seasons of fishing throughout are well understood. Success mainly depends upon a general fishery carried on throughout the year, for no project will be profitable that has only to depend upon one system of fishing, or rather is confined to the capture of one kind of fish, or the fishery of a season.

The Charter granted under powers vested in the Queen (1st Victoria, ch. 73), gave powers to the Company to establish and maintain stations at such places along the entire coasts of Ireland as the said Company shall from time to time select. Powers also to purchase land, and such wharfs, docks, houses, offices, and buildings, necessary or proper. The liabilities of the shareholders were restricted to all debts of the Company to such extent only per share, upon the shares held by them respectively, as shall then for the time being, not be paid up. The Company had also the power to borrow to the extent of £20,000, if necessary.* The calculations made of the expenditure necessary for the station at Dingle, and the returns which the limited outlay had realised, warranted the Directors in considering the success of the Company as certain, under the provisions granted by the Charter; therefore, as the sanction of the Board of Trade would not be given for its renewal, the Directors declined to enter into any new arrangements or plans. Mr. Andrews did not wish to convey that Mr. Cardwell intentionally broke up the Royal Irish Fisheries Company, by not assenting to the continuance of the Charter, but merely that he was desirous (being adverse to chartered bodies) to have the views entertained with regard to his Limited Liability Act.

With regard to Mr. Blake's, Inspector of Fisheries, observations, no doubt that well-conducted curing establishments would be profitable, but not in the manner carried on in 1846, though the prices of fish at that time were very low. The prices of cured fish at the present day were more than double, ling being £35 per ton, and upwards, and dried hake sold by the fishermen had brought £20 per ton.

As to the views of Norwegian naturalists, with regard to the ova of fish, they were very absurd, for it has even been asserted that the ova of salmon floated down the river until resting for hatching. Mr. Andrews did not this evening intend to enter into the science of the subject. Mr. Andrews was decidedly opposed to the combination of farming and fishing—at least to loans being made to such employments, for it was not unfrequently found that the moneys were more applied to the land than to fishing pursuits. The trustees of the "Society for Bettering the Condition of the Poor of Ireland" had not more than £36,000 available or free, and which, according to the trust, was to be principally distributed in aid of, and promotion of the sea-coast fisheries of Ireland. Of that sum, already nearly £13,000 was outstanding, and more, as the season advanced, would be lent. No doubt, as Mr. Blake said, a considerably larger sum could be lent, and applications would be found from such as Mr. Blake advocated, from most

* Fees paid on Royal Charter, viz.:—

	£	s.	d.
To Secretary of State's office, and for passing the Charter,	67	9	6
Attorney-General's office for Bill,	36	15	0
Signet office,	67	8	0
Privy Seal office,	68	2	0
Patent office,	96	19	8
Messengers, &c.,	1	11	6
Total of fixed Fees,	£338	5	8

parts of Ireland, but assistance to such applicants could not be considered either useful or safe as regards the fisheries. Of 50 canoes with three men to each, desiring relief, it is stated on reliable information, that "not more than the crews of 18 or 20 canoes are employed in fishing; the remainder are engaged at sea-weed, and the like," and these applicants have no security to offer. As to the very tempestuous nature of the coasts of Ireland, Mr. Andrews had experienced all seasons, and he did not consider it to be more so than what the boats encountered in the North Sea, and off the Scilly Islands. The Kinsale mackerel boats fished from twenty to forty miles off the land, where they frequently had heavy seas and strong tides to contend with. The well-known first-class hookers of Kinsale, when the men had the means of fitting them out, often fished to the westward of Cape Clear, and Mizen Head, and off the South-west coast. At Teelin station, Donegal Bay, there are 14 strong row-boats, with seven men to each, supplied with nets, &c., but they are not able to keep at sea, or go to the deep water fishing: able and well-found decked boats are required, with skilful seamen, that can fish in most weathers throughout the year.

The Chairman said that they were greatly indebted to Mr. Andrews, not only for what he had done on the present occasion, but for his exertions for many years on behalf of the fishing industry. With reference to the spawn, he (Mr. Pim) was glad that it was not within the reach of the trawler wherever it was. As to the half-farming and half-fishing system, he thought that the man who went to sea now and then, and benefited himself, benefited the country. He had no faith in companies for any object that was not too large for private individuals. It was very satisfactory that Mr. Andrews' society had been so successful in avoiding bad debts, and it was not clear that more money could not be expended in loans for the same purpose and with the same success. No doubt the work would require a great deal of care, for it was easy to see that in this country, as well as in any other, it was easy to lend money and not get it back.

The meeting then terminated.

XXXI.—*On the Anthropoid Apes.* By ALEXANDER MACALISTER, M. B., Professor of Comparative Anatomy in the University of Dublin, and Honorary Professor of Artistic Anatomy, R. D. S.

[Read on Monday, December 16, 1872.]

IN no part of the system of Nature has so much difference of opinion been expressed as in relation to man's place in creation; some zoologists, like Goodsir, De Quatrefages, and Geoffroy St. Hilaire, placing man in a separate kingdom, removed from all affinity with the other animals; others, like Professor Owen, make him a separate sub-class of the mammalia; others, like Blumenbach and Cuvier, make of him an order only; and finally, others, like Linnæus, Huxley, and many of our more skilled comparative anatomists of the present day, regard him as a member of a family in the order primates. The reason of this great variety of opinion is simply this, that the authors referred to attach a varying amount of importance to the psychical endowments of man. Certain it is that, as Professor Huxley has put it, if we were inhabitants of another planet, and had brought to us by some enterprising traveller the body of a man in a barrel of spirits, together with that of a monkey—knowing, as we would in such circumstances,

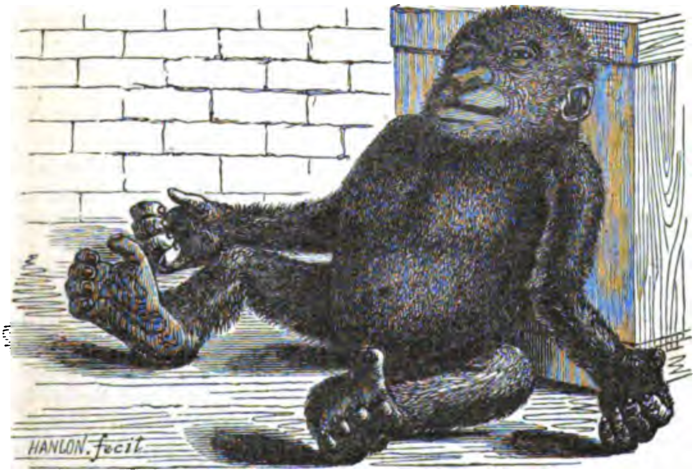
nothing of any higher psychical characteristics in one than in the other, we would refer them to very closely allied positions in the series of life. As I intend to look at the neighbours of man purely from an anatomical stand-point this evening, we will, and I think properly, disregard this great psychical aspect of the subject, and confine ourselves to the more purely morphological.

Some zoologists have disputed the naturalness of the assemblage together of the Gorilla, Chimpanzee, and Orang, as anthropoid Apes. Professor Giebel says that they have no other resemblance to each other than that of size, and observes that in cranial characters and in erect position the callosity bearing Gibbons and some of the Cebidæ approach Man even closer than do these three.

M. Lartet and Sir C. Lyell also regard the Gibbons, especially the siamang, as really the nearest to man of the anthropoids, on account of their globular crania, their smaller jaws and teeth, and their more erect spine.

I. Our first point will be the size and proportion of the anthropoids, and the data upon which I make these and all the succeeding observations are the following :—

1. The dissection of a young female Gorilla figured below. 2. The examination and measurement of three stuffed specimens. 3. The descriptions of Duvernoy, Owen, Mivart, Halford, and Huxley, of different



parts of Gorillas. 4. The dissection of two Chimpanzees. 5. The examination of two living and five stuffed Chimpanzees and skulls. 6. The descriptions of dissections by Wyman, Humphry, Huxley, Champneys, &c. 7. The examination of one living and four stuffed Orangs, in-

cluding the magnificent specimen now in this Society's Museum. 8. The account of the dissections of this animal by Church and Halford.

The height of the adult Gorilla has been found to vary as follows: 5 ft. 6 in. (adult male, B.M.); 5 ft. (Bowditch); 4 ft. 10 in. (Du Chaillu).

The height of the adult Chimpanzee is stated as from 5 ft. (Savage) to 4½ ft.

The height of the Orang-utan, 4 ft. 1 in. (adult male, Von Wurmb), 4 ft. 5 in. (ibid.), 5 ft. 2 in. (Spencer St. John).

The average height of savage Man is about 5 ft. 4 in.; of the Dyaks in Borneo it is 5 ft. 3 in.; of the Veddahs, 5 ft. 2 in. We leave out of account the described dwarf races, Obongoes, Dokós, &c., until the accounts are confirmed.

The breadth of shoulders in the specimen of the Orang now in our Museum is 2 ft. 6 in.; that of the Chimpanzee is not quite 2 ft. 4 in.; and the Gorilla about 3 ft. (B. M.). In savage Man the breadth averages 1 ft. 8 in.

The length of arm in the Gorilla is 3 ft. 6 in., the humerus being longer than the ulna, as it is in the Chimpanzee. Indeed the upper limb is in length, when compared to the trunk, very little different from that in Man, the wrist in both being opposite the tuber-ischii; in the Chimpanzee the arm is probably longer, the ulna being nearly equal to the humerus. In the Orang—3 ft.,, the ulna exceeding the humerus, and the wrist being opposite the knee joint.

In Man, 2 ft. 4 in., the proportional length only differs from that of the Gorilla in the hand region.

The length of lower limb in the Gorilla is 2 ft. 7 in., or to end of mid-toe, 3 ft. 5 in.

In the Chimpanzee, 2 ft. 1 in.

In the Orang, to the end of the middle toe, 2ft. 10 in.

In Man it is over 3 ft. 6 in.; and thus, while in Man the leg is longer than the arm, and the latter reaches the middle of the thigh, in the Gorilla it reaches the knee; in the Chimpanzee, the middle of the tibia; in the Orang, the ankle; and in the Gibbon below the foot.

The second point we will study is the surface-covering of these animals. Man certainly stands apart from the rest by his general bareness; but everywhere except on the palms of his hands, soles of his feet, and where the skin is exceedingly thin, as on the eyelids and the red margins of the lips, hair follicles exist, and are developed to a greater or lesser proportional extent; and as Professor Eschricht has shown, the direction of these rudimentary surface-hairs in Man is precisely similar to that in the anthropoid Apes. In the Gorilla the covering of hair is of a reddish or dusky grey colour, and varies in tint in different parts, being more rufous on the head, darker on the trunk; the breast and back of the great male Gorilla in the British Museum are covered with short hair. Our specimen was darker than usual, but this was to some extent due to its maceration in arrack. The

Chimpanzee is very much darker, black, or nearly so, and the hair is thin on the shoulders and front of the neck. The Orang-utan is covered with rufous hair varying in tint slightly in different regions.

The most hirsute race of men are the Ainos of Japan, and the Orang Kabu or aborigines of Sumatra, who, Mr. Gibson tells us, are covered with soft woolly hair, have a primitive language, and learn any other with difficulty. In all the anthropoids, except the male Orang, who has a subgenial beard, the facial hair is scanty, neither of the others presenting to us a large or even moderate moustache or beard; in this respect they are much exceeded by the Brachyteles Satanas of South America, and thus they resemble almost all the lower races of men—among whom the presence of a beard is the exception, barefacedness the rule.

Thirdly, we will contrast the bony structures of the four forms before us, pointing out in a very concise list the divergences in the groups: and, first of all in the axial skeleton we find the following characters:—1. In Man the axis of the vertebral column is vertical, and the perpendicular dropped from the atlas cuts the column in five points; in all the anthropoids the axis is oblique, and the perpendicular cuts it in three or four only. The curves in the spine of the Apes exactly correspond to the curves in the spine of an exceedingly young human infant, and they never assume the adult human lumbar curve. The articular facets in the human spine allow of a considerable amount of rotation, more than in any of the anthropoids.

The Chimpanzee and Gorilla have thirteen ribs, and thus thirteen dorsal vertebræ. The Orang-utan has only twelve, as in Man, but the numbers constitute only a trivial difference, for the first-named pair have only four lumbar vertebræ, and every human anatomist knows very well that it is by no means an uncommon arrangement in Man to have a lumbar rib, that is, thirteen rib-bearing vertebræ, and four true lumbars. The cervical spines in the anthropoids are longer than in Man, and they are generally undivided, the sacrum is straighter as a rule, but human sacra are often quite as straight. The lateral ossific nuclei in the meso-sternum are slower in consolidating in the Orang and Gorilla than in Man.

In contrasting the skulls of the four animals, we are struck at once with the great difference in the cranial capacity in the several forms. The brain cavity in the average human skull is about 88 cubic inches; but specimens of adult skulls have been measured, which sank as low as 63 or 59 cubic inches. In man also the cerebral cavity is more than 2½ times the length of the basi-cranial axis. In the Gorilla the cranial capacity varies between 25 and 35 cubic inches; in the Orang 24; in the Chimpanzee 26. The smaller size of the brain-case in these anthropoids is supplemented by a large development of the jaws, whose projection forward gives the fierce expression to their faces. We notice also a stronger development of the muscular ridges, temporal and occipital, and the presence of a nasal spine; a retrogression

in the position of the foramen magnum, as contrasted with Man; an elongation of the facial region; a narrowing of the anterior fossa, is noticed in all. In the Orang, as in Man, there is no postethmoid contact of the orbital plates of the frontal; but such exists in the Gorilla and Chimpanzee. They all agree with Man in the consolidation of the basisphenoid and presphenoid bones, and therein differ from most of the lower monkeys. In these three the premaxilla is not, as in the human embryo, covered by an inward process of the maxilla, and hence there is an anterior trace of the intervenient suture; but it is proportionally less in the Gorilla than in the others. The nasal bones resemble those of the negro in their tendency to ankylosis, but are slightly ridged in the Gorilla. There is only a rudimental paroccipital process in all, as in Man. The squamosal suture in the Gorilla and Chimpanzee touches the frontal, but does not in the Orang or in Man. The condyloid and petrous processes are larger in Man than any other animal. The mastoid processes are pneumatic in the Chimpanzee, as in Man. The Gorilla has a sphenoidal spine like Man, and a vaginal process on the temporal bone. In Man the permanent canine is cut before the second molar.

The appendicular skeleton presents to us several features in detail; but as Mr. Mivart has, in his admirable Paper in the Philosophical Transactions given these *in extenso*, I will not go to the unnecessary labour of reproducing the details here; it will suffice to enumerate the following:—

The thumb reaching to the middle of the first phalanx of index; the tibia being proportionally long, and descending lower behind than in front; the descent of the fibular below the tibial malleolus; the comparative shortness of the foot; the great breadth of the superior surface of the tuberosity of the calcaneum; the greater length of the shaft of the femur; and the greater prominence of its linea aspera; the presence of a flattened ento-cuneiform-halluceal articulation; the greater length of his first foot-digit.

The muscular systems of these four types present to us a great general similarity of plan. In man we find a large, well-developed series of facial muscles. The Gorilla has some of these strongly marked—the elevator of the upper lip, the zygomatic, and the orbicular muscle of the mouth. In the Chimpanzee the same muscles are moderately well-marked, as are the orbicular muscles of the eye and the occipito-frontal. The ear muscles are not much larger in these than they are occasionally in Man. The sterno-mastoids in the Gorilla have a prominent mastoid process for their insertion, which occurs in no other animal but Man. The anthropoids agree with Man, and differ from all the other primates in having no occipital rhomboid, while they ordinarily differ from him by possessing a dorsi-epitrochlear, and an omo-atlantic muscle; these, however, have both been found in Man over and over again, and they are both unquestionably smaller in the Gorilla and Chimpanzee than in any other of the monkey tribe. In Man there is a larger

development of the deltoid muscle, but the anthropoids agree with him, in having the supraspinatus smaller than the infraspinatus. Man also was supposed to possess, as a peculiarly human attribute, a coronoid head for his pronator radii teres muscle; but this he holds in common with the Gorilla; the same animal has a radial origin for his superficial digital flexor, and thus stands alongside of man in this characteristic.

The great muscular characteristic of Man is the apparatus whereby he moves his thumb, an organ provided with one long flexor, three long extensors and four short muscles. In the Orang and Chimpanzee the provisions for its motion are comparatively imperfect, there are only two extensors (none existing for the first phalanx); there is no separate long flexor, but from the deep flexor for the other digits a fine thread passes to the pollex, thus its flexion by this agent cannot take place independently of the other fingers; there are, however, in these two animals, the same four short muscles which exist in Man, an *abductor*, an *opponens*, a *flexor brevis* and an *adductor*. The Gorilla has a singularly interesting and suggestive arrangement in its manus, namely, that the long flexor tendon is present, but devoid of muscular fibres; it arises from the front of the carpal bones, passes in its ordinary course between the two tendons of insertion of the flexor brevis, and is inserted into the last phalanx; it has not the slightest connexion with the flexor of the other fingers, and in this respect differs from the flexor of the thumb in every other animal but Man: in fact, we have here the condition which would be produced if in the human forearm the thumb ceased to be used, and the muscular part of the long flexor was allowed to waste. Cases are on record in Man, in which the tendon for the pollex was joined to that of the index, but such are exceedingly rare. Although in the Gorilla there is no *extensor primi internodii pollicis* yet the *extensor ossis metacarpi* is segmented, showing a tendency to the formation of a second muscle. In the Gorilla, also as in the Chimpanzee, the *extensor* of the little finger has normally no attachment to the ring finger, and the extensor indicis is confined in its insertion to its own digit: in these respects these animals resemble Man, and differ from all the other quadrumana. Man exceeds all his allies in the large size of his spinal muscles: in his erect position these lie in deep channels along either side of the median line. In the anthropoids there is no such a system of arching, but the line of the occiput is directly continuous into the nucha without any backward concavity. Among the primates, the highest of the South American monkeys range next to Man in this respect, even higher than the Gorilla. Man also, by virtue of his erect position, has an enormously developed external gluteus muscle, which exceeds by four-fifths the weight of the middle gluteus. In the Gorilla the proportions are as 13·29 : 13·28. The same posture in man renders necessary an equality, or preponderance of the extensors over the flexors of the knee; in the lower primates these are to each other as 11 : 16—but in the Gorilla, they are as 11 : 8.

Man also in his lower extremity has a preponderance of the extensors of the ankle over the flexors of the toes. In the Gorilla there is a smaller development of the former, and the solæus has no tibial origin. One muscle in the foot of Man has never yet been found in any other animal; this is the peroneus tertius: man also has an undivided tibialis anticus, and the four slips of his flexor brevis digitorum pedis arise from the calcaneum.

In connexion with the muscular system and motions of these animals, it is interesting to contrast the hand and foot of an anthropoid Ape with the corresponding organs of Man. The human hand is shorter, broader, has a much larger thumb; in the extended position the tip of this digit reaching to the lower third of the first phalanx of the index. In the Chimpanzee it reaches to the base of the first phalanx, in the Gorilla a little farther, in the Orang scarcely so far.

Thus in Man's hand the thumb can be firmly opposed to any of the fingers, in the hand of an anthropoid, opposition is feeble.

On the other hand, in the human foot in ordinary conditions there is little or no grasping power, and what power of prehension does exist depends more upon apposition than opposition. In the anthropoids, on the other hand, there is a large hallux, which is well and freely opposable, and powerful muscles of the same kind and arranged on the same plan as those in man, to move it; hence the hinder hand is the agent used by the Orang or Gorilla in actions requiring a forcible grasp. It is true, however, that mankind, at least the more civilized races, have forfeited the motion of the hallux by the artificial constraints of feet-coverings, and the actions, long and hereditarily prevented by shoes, have diminished to a minimum. That this is true is evidenced by the fact that many races of men do really use the foot as a prehensile organ. Georges Pouchet tells us that Nubian negroes prefer to seize the rein of their horses with their toes in riding, so as to leave their hands free. Büchner, in his Vorlesungen über die Darwin'sche Theorie, p. 197, gives many instances of the use of the foot for prehension, of negroes and others climbing trees with their feet, leaping from branch to branch without using their arms. In a Mincopi foot the great toe was farther separated from the other toes than an adult European foot, as it is in most negroes, and had a more oblique ento-cuneiform metatarsal articulation, and as Professor Wyman has shown, as it is in a very early period of human life; and in Japan the feet-coverings are fastened by a strap passing between the great and second toes. In several Japanese prints in my possession feet are represented with widely abducted halluces.

In the arterial, and other vascular systems, the anthropoid Apes are absolutely identical with Man, and the same is true regarding the peripheral nervous system, even such complicated nerve plexuses as the brachial, lumbar and cervical are built up on the same plan as those in Man. The brain alone of all nerve-organs exhibit a difference, but it is purely one of degree. We have in the human brain a very much

larger bulk, a more complicated series of convolutions, a smaller size of the olfactory nerves, and a separation of the mammillary bodies into two. The cerebrum especially is of far greater bulk, but its inner structure is exactly similar to that of the anthropoid's sensorium. The weight of the brain of the Gorilla is about 24 oz., that of a human brain varies from 66 oz. (the highest), to 31 oz., the average negro (out of 141) being 46 oz. In the Chimpanzee it is about 18 oz., in the Orang, 16 oz. The brain of a bushwoman, Marshall found to weigh 21½ oz., Murie and Flower 38 oz., that of an Australian 30 oz. The anterior lobe is much smaller and tapers forward. The size and complexity of the convolutions vary little in the anthropoids, that of the Orang coming nearer to the human than that of either the Gorilla or Chimpanzee.

Among the visceral apparatuses we may notice the following as some of the most striking points, both of resemblance and dissimilarity. Mr. Darwin has called attention to the inflexed lingula of the helix of the ear, as the rudiment of the erect tip to the ear in some ancestral form. In the ear of the anthropoids we notice the following structural points; the Chimpanzee's ear is large, flattened, and with an expanded helix. That of the Gorilla is beautifully shaped, very like the human in most respects, as will be seen in Mr. Ford's beautiful drawings in the Transactions of the Zoological Society.

The noses of the anthropoids resemble that of Man in having down-directed openings and a narrow inter-nasal system; they are peculiar in the greater thickening of the alar cartilages, but to this we are conducted by the arrangement in many negro tribes. The prominent nose of Semnopithecus narica adduced by Darwin is not an instance of human affinities, as the protuberance is not all based upon an elongated nasal bone. We notice in these the tendency to early coalescence of the nasal bones, so that in an adult skull they present to us the appearance of a single and undivided scale of bone. This is, singularly enough, the arrangement found in negroes whose nasal bones exhibit a remarkably early coalescence.

In the dissection of the Gorilla, I found what seemed at first sight a rudimental cheek pouch: just at the point on the buccinator muscle where it is perforated by Steno's duct, a soft sacculated body presented itself to view, lying anterior to the border of the masseter: this, however, has no wide communication with the mouth, and a careful dissection unravelled it into a cluster of molar glands similar to those lobulated mucous glands described in Man by Nathaniel Ward: the corresponding structures in the Chimpanzee are very much smaller and less definite.

On contrasting the tongue of the Gorilla and the human tongue, very little apparent differences of importance exist, except a diversity in arrangement of the papillæ.

In the small intestine of the anthropoids valvulæ conniventes are very feebly developed, and the canal is rather longer than in Man.

In the digestive canal, the Orang, Chimpanzee, and Gorilla agree with Man, and differ from the lower monkeys in having a moderate vermiform appendix; the Gibbons have it only in rudiment.

Having thus in detail contrasted these four remarkable forms, we are in a position to reason regarding their relative positions. Man stands distinguished from the others by the enormous preponderance of his brain, the perfect specialization of his thumb, the imperfect opposability of his hallux, the bareness of his surface, the erectness and sinuous flexures of his spine, his possession of eight carpal bones.

These characters, though not of ordinal value, are yet of sufficient importance to justify us in placing the genus Homo as the type of a family of the Primates.

Next in order comes the Gorilla, characterized by the greater strength of the muscular ridges on the skull, the human type of the ear, and anthropoid length of the upper limb, the humerus exceeding the ulna, and to him we assign the highest place in the second family of the Primates. The Chimpanzee comes third in rank, and is distinguished by his less cristate skull, his longer scapula and upper limb, his larger ear and eight carpal bones—smaller brain and body in general. These characters, as the expression of a different idea from those of the Gorilla, justify us in raising each to the rank of a distinct genus; hence we call the one by the name Gorilla—the other by the name Troglodytes. Two species of Chimpanzee are known.

Lastly, the Orang-utan, with his broader head, his nine carpal bones, larger laryngeal pouches, small and often rudimentary terminal phalanx on his hallux, exceedingly long upper limbs, embodies an additional generic idea, to which we give the name Pithecus, and we recognise at least two specific forms.

The geographical range of these species is the last point which we will touch on, and a few words will suffice for its discussion, leaving Man out of the question as universally distributed.

The Gorilla is limited in its range to the district of country traversed by the Gaboon, Fernandez Vas, and Muni Rivers in West Africa, a district whose largest diameter is not over seven hundred miles. The Chimpanzees extend over a rather larger tract of West Africa, but still are limited to a very circumscribed area. The Orangs are found only in the Islands of Sumatra and Borneo.

Their being thus so localized is the reason for the scantiness of our knowledge on the habits and nature of the group. The Orang is the best known, and owes its name to the Malay word for Man, Orang-utan = wild man of the woods. Orang Kabu = aboriginal man. Tulpius, its first describer, in the seventeenth century brought home a picture of this animal, and Vosmaer, Von Wurmb, and Camper contributed additional facts to our knowledge of this remarkable genus.

The Chimpanzee, called Nstiego in the Camma language, Enche-eko, in the Mpongwe (Enge, being the Bassa for Man), was first described by an old English traveller, Andrew Battel, who lived in the Kingdom of

Congo for some years, and on his return communicated his stories to the author of "Purchas, his Pilgrimage" (published 1625, vol. 2, p. 981). He called it the Engeko. In 1744 Smith described a large ape under the name Mandrill, which was a Chimpanzee; and still earlier, in 1699, Tyson published a work on the Anatomy of a Pygmie which was a young Chimpanzee from West Africa, although he called it an Orang-utan. The name is probably derived from Kima, or Chia-ama (the Dualla for a monkey) combined with the Camma name Nstiego.

The Gorilla is supposed to have been the animal met with by the Carthaginian traveller, Hanno, who, in his Periplus, B. C. 350, describes an island inhabited with wild men with hairy bodies, whom the interpreter called "Gorillai." Three females were caught, who bit and scratched those who led them. These they killed and flayed, and brought their skins, stuffed with straw, to Carthage. Dr. Savage and Mr. Bowditch, as well as Du Chaillu and Winwood Reade, have given us additional information regarding this animal. Andrew Battel speaks of it as the Pongo. Dr. Savage, first in modern times, called it by Hanno's name, Gorilla. The native name is Engina or Gina in Mpongwe (which language takes its name from the tribe, who are the Pongwe or related to Pongoes). It is also called Ngyula, in the Dualla language, Nigu being the Kru for Man, and Gai its Bassa equivalent.

XXXII.—*Return of Donations to the Royal Dublin Society.*

THE LIBRARY.

THE GOVERNMENT OF SOUTH AUSTRALIA.

Adelaide Almanac and Directory for South Australia, 1873, . . . By Josiah *Boothby*, Esq. (Corr. Memb. Statistical Soc. Lond.) 8vo. *Adelaide*, 1873

THE AUTHOR.

Alanus (Henr.), Observationes in S. Julii Frontini Strategematica. 8vo. *Dublinii:* . . . 1873.

Codicum Suetonii suorum duorum specimen dedit, nec non observationes, aliquot addidit Henr. ALANUS. 8vo. *Dublinii:* . . . 1873

HENRY DIX HUTTON, ESQ.

Amtlicher Bericht über die 25. Versammlung deutscher Land-und Forstwirthe zu Dresden, vom 25, junii bis 1, Juli 1865. 8vo. *Dresden*, 1866.

HENRY DIX HUTTON, ESQ.

Annalen der Landwirthschaft in den Königlich Preuszischen Staaten. Herausgegeben . . . vom . . . C. v. SALVIATI . . . Fünfundzwanzigster Jurgang. Neunundvierzigster Band. 8vo. *Berlin*, 1871

HENRY DIX HUTTON, ESQ.

Association Internationale des Travailleurs a Paris, Troisième Procés de . . . 12mo. *Paris*, 1870

THE AUTHOR.

Brady (Thomas F., Inspector of Irish Fisheries), Distress on the Islands of Boffin and Shark, County Galway—1873,— Report of the Proceedings taken to relieve that distress, chiefly by the Promotion of the Fisheries. . . . 8vo. *Dublin:* 1873

THE BRITISH ASSOCIATION.

British Association for the Advancement of Science; Report of the Forty-second Meeting held at Brighton in August, 1872. 8vo. *London:* 1873

HENRY DIX HUTTON, ESQ.

Bulletin des Lois, arretés décrets et proclamations de la *Commune de Paris.* Recueil de tous les actes officiels du 26 mars au 23 mai 1871. 8vo. *Paris* 1871

Cadet (M. le Docteur Socrate . . . de Rome), Novelles Études sur la Cholera Asiatique.——le Sulfur Noir de Mercure proposé . . . Traduction du Comte Charles des DORIDES. 8vo. *Rome,* 1872

HENRY DIX HUTTON, ESQ., M. R. D. S.

Carte Manuscripts in the Bodleian Library, Oxford.—A Report . . . by C. W. RUSSELL, D. D., and J. P. PRENDERGAST, Esq., Barrister-at-Law. . . . 8vo. *London,* 1871

THE LIBRARIAN, TRINITY COLLEGE, by H. D. HUTTON, ESQ.

Catalogus Librorum Impressorum qui in Bibliotheca Collegii Sacrosanctae et Individae Trinitatis, Reginae Elizabethae, juxta Dublin, adservantur.
Tomus Primus, cum Supplemento,
continens Literas A et B. Folio. *Dublinii,* 1864

HENRY DIX HUTTON, ESQ.

Chevalier (Lucien Le), La Commune—1871—Le coup d'état du 18 mars . . . 12mo. *Paris* 1871

HENRY DIX HUTTON, ESQ.

Commune (la) dèvant les Conseils de Guerre . . .
1re-2e-3e-4e et 5e série.
Deuxieme series: Les Petroleuses. 8vo. *Paris* 1871

THE AUTHORESS.

Cooke (Mrs. John), The Temple of the Lord, and Minor Poems. 16mo. *Dublin,* 1863

THE AUTHOR.

Crace-Calvert (Dr. F., F. A. S., F. C. S., . . .), On Protoplasmic Life, and the action of Heat and antiseptics upon it. 8vo. *Manchester:* 1873

THE AUTHOR.

Crace-Calvert (F., Ph. D., F. R. S., F. C. S., . . .), Experiments on the Oxidation of Iron, . . . 8vo. *Manchester:* 1872

THE KING AND QUEEN'S COLLEGE, OF PHYSICIANS IRELAND.
Dispensarius . . . The Irish Poor Law Medical System . . .
Third Edition. 12mo. *Dublin:* 1870

THE AUTHOR.
Elliot (Sir Walter, K. S. I., F. L. S., President), Extracts from the opening address of the President of the Botanical Society of Edinburgh, on 3rd November 1870.
From the Transactions of the Botanical Society, Vol. XI.
8vo. *Edinburgh:* 1871

HENRY DIX HUTTON, ESQ.
Festschrift fur die xxv. Versammlung deutscher Land-und Forstwirthe zu Dresden 1865. 8vo. *Dresden.* s. a.

THE AUTHOR.
Fitzgibbon (Gerald, Esq., Master in Chancery, . . .), A Banded Ministry and the Upas Tree. 8vo. *Dublin:* 1873

HENRY DIX HUTTON, ESQ.
Fribourg (E. E., l'un des Fondateurs), L'Association Internationale des Travailleurs . . . 8vo. *Paris* 1871

HENRY DIX HUTTON, ESQ.
Hanssen (G., Prof. in Berlin), Zur Geschichte der Feldsysteme in Deutschland.
[Besonderer Abdruck aus der *Zeitschrift für Staatswissenschaft.* 1865. Heft 1 & 11]. 8vo. Tübingen 1865.

HENRY DIX HUTTON, ESQ.
Henryot (Arnold), Paris pendant le Siege—1870–1871.
12mo. *Paris* 1871

HENRY DIX HUTTON, ESQ.
Instruction publique—Projet de Réorganisation des Écoles de la ville du HAVRE. 12mo. *Havre* 1871

HENRY DIX HUTTON, ESQ.
International Working Men's Association, Resolutions of the Congress of Geneva, 1866, and . . . of Brussels, 1868.
12mo. *London* s. a.

THE EDITOR.
Irish Monthly Illustrated Journal. Edited by T. C. *Irwin.*
Nos. 1, 2. 8vo. *Dublin* 1873

THE LORDS COMMISSIONERS OF H. M. TREASURY, BY THE LORD CLERK REGISTER OF SCOTLAND.
James (Colonel Sir Henry, R. E., Director of the Ordnance Survey), Facsimiles of National Manuscripts of Scotland, selected under the direction of the Right Hon. Sir William GIBSON-CRAIG, Bart., Lord Clerk Register of Scotland . . .
Part III. Folio. *Edinburgh.* 1873

Henry Dix Hutton, Esq.
Joigneaux (P. Député de la Cote-d'Or), Nouvelles Lettres au Paysans. Deuxième edition. 12mo. *Paris* 1871

Henry Dix Hutton, Esq.
Judeich (Albert, Kreisteurrathe zu Dresden), Die Landrentenbank in Konigreiche Sachsen . . . 8vo. *Leipzig*. 1862

Henry Dix Hutton, Esq.
Judeich (Albert, Königl. sächs. Kreisteurrathe zu Dresden), Die Grundentlastung in Deutschland. 8vo. *Leipsig:* 1863

The Publishers.
Kinahan (G. H., M. R. I. A., . . .) and *Close* (M. H., M. R. I. A.), The General Glaciation of Iar-Connaught and its neighbourhood in . . . Galway and Mayo. With a Map. 8vo. *Dublin:* 1872

Henry Dix Hutton, Esq.
Königl. Sachsiche Landesscultur-Gesetze . . .
Mit Erlauterungen von Ferdinand Kunzel . . .
8vo. *Leipzig*, 1872

Henry Dix Hutton, Esq.
Landes=Oeconomie=Gesetzgebung des Königreichs *Hannover* . . .
Zweite Auflage. 8vo. *Hannover*. 1846

Henry Dix Hutton, Esq.
Lanjalley (Paul) et Paul *Corriez*, Histoire de la Révolution du 18 mars. 8vo. *Paris* 1871

Henry Dix Hutton, Esq.
Lasteyrie (Ferdinand de, . . .), Le Paysan, ce qu'il est—ce qu'il devrait être . . , 16mo. *Paris* 1869

Mr. H. J. Fennell.
Licentiate Apothecaries of Ireland, List of.
With appendix. 8vo. *Dublin:* 1872

The Author.
Lloyd (Humphrey, D. D., D. C. L., Provost of Trinity College, Dublin, . . .), Elementary Treatise on the Wave-Theory of Light. Third Edition, Revised and Enlarged. 8vo. *London:* 1873

Henry Dix Hutton, Esq.
Lockroy (Édouard . . .), La Commune et l'Assemblée.
8vo. *Paris* 1871

Henry Dix Hutton, Esq.
Malon (B.), Exposé des Écoles Socialistes Françaises . . .
Suivi d'un aperçu sur le Collectivisme International.
12mo. *Paris* 1872

HOMMAGE DE LA SOCIÉTÉ DE PHYSIQUE ET D'HISTOIRE NATURELLE DE GENÈVE.

Memoires de la Société de Physique et d'Histoire Naturelle de Genéve. . Tome vingt-deuxiéme. 4to. *Genéve* 1873

THE AUTHOR.

Molloy (the Rev. Gerald, D. D., Professor of Theology in the Royal College of St. Patrick, Maynooth), Geology and Revelation: or, the Ancient History of the Earth, considered in the light of Geological Facts and Revealed Religion.
Second Edition. *London,* 1873

THE AUTHOR.

Morgan (J., M. D., F. R. C. S., . . .). The Danger of Chloroform and the Safety and Efficiency of Ether, . . . in Surgical Operations . . . 8vo. *London,* 1872

THE KING AND QUEEN'S COLLEGE OF PHYSICIANS, IRELAND.

Poor Law Medical Officers' Association, Laws, List of Officers for the year 1871, and of . . . Members: . . . Annual Meeting . . . held . . . July 13, 1870. 8vo. s. l., s. a. [*Kensington:* 1870]

HENRY DIX HUTTON, ESQ.

Procès de l'Association Internationale des Travailleurs—Première et deuxième Commissions du Bureau de Paris—
Deuxième édition. 12mo. *Paris* 1870

THE COUNCIL OF THE BELFAST NATURAL HISTORY AND PHILOSOPHICAL SOCIETY.

Proceedings of the Belfast Natural History and Philosophical Society, for the Session 1871–72.
With Obituary Notice of the late Robert PATTERSON, Esq., F. R. S.
8vo. *Belfast:* 1873

HENRY DIX HUTTON, ESQ.

Rapport de la Commission de Réorganisation des Écoles communales du Havre 8vo. *Havre* 1871

MR. THOMAS BEANY.

Reichel (Charles Parsons, D. D., Vicar of Mullingar . . .), Shall we alter the Ordinal?— . . . Submitted to the Revision Committee of the Church of Ireland . . . 8vo. *Dublin,* 1872

MR. THOMAS BEANY.

Reichel (Canon) and *The Provost of Trinity College,* Speeches delivered in the General Synod on the Alteration of the Ordinal . . . Examination of the Question in its legal Aspect, by Wm. BROOKE. Esq., Q. C., M. C. 8vo. *Dublin,* 1873,

THE KING AND QUEEN'S COLLEGE OF PHYSICIANS, IRELAND.

Reports of the Royal Medical Benevolent Fund Society, for the years ending May, 1863–1864–1865–1867–1868.
12mo. *Dublin:* 1863–64–65–67–68

The King and Queen's College of Physicians, Ireland.

Report of the Joint Committee on State Medicine of the British Medical and Social Science Associations, on the Report of the Royal Sanitary Commission. 8vo. s. l., s. a. [*London:* 1871]

Richard Grattan, Esq., M. D.

Report of . . . the case of Richard Grattan, Esq., M. D., Ex-J. P., Complainant: Lord John Russell, Lord Clarendon, and Ex-Chancellor Brady, Defendants: . . . Measures for the Regeneration of Ireland. 8vo. *Dublin:* 1858

Henry Dix Hutton, Esq.

Richardet (G., Rédacteur du *National*), Quatre jours de prison sous la Commune. 8vo. *Paris* 1871

Henry Dix Hutton, Esq.

Rural (un), Ils en ont menti.
Nouvelle Edition. 12mo. [*Paris*] 1871

The Smitsonian Institution.

Smithsonian Contributions to Knowledge,
Vol. XVIII. 4to. *Washington:* 1873

The Somersetshire Archæological Society.

Somersetshire Archæological and Natural History Society's Proceedings, 1871. Vol. XVII. 8vo. *Taunton,* 1872

Henry Dix Hutton, Esq.

Stark (Dr. Carl, . . .), Die psychische Degeneration des französischen Volkes, . . . 8vo. *Stuttgart.* 1871.

The Orator.

Stoker (Abraham, A. B., Auditor), University of Dublin College Historical Society. Address delivered . . . at the First Meeting of the twenty-eighth Session . . . Nov. 13, 1872, by the Auditor. 8vo. *Dublin:* 1872

The Author.

Talbot de Malahide (Lord, F. S. A., M. R. I. A., F. R. S.). The Light Literature of Spain; particularly the Works of Fernan Caballero: . . . a Lecture delivered . . . the 1st May, 1872, at the College of Science, St. Stephen's Green, Dublin. 8vo. *Dublin,* 1872

Henry Dix Hutton, Esq.

Testut (Oscar)—L'Internationale . . .
Troisième edition . . 12mo. *Paris* . . . 1871

Henry Dix Hutton, Esq.

Thaer (Dr. A.). Ueber die Stellung der Tagelöhner, insbesondere in der Mark Brandenburg. . . . 8vo. *Berlin,* 1865

Henry Dix Hutton, Esq.

Thaer (Dr. A., Privatdocent der Landwirthschaft en der Konigl. Universität zu Berlin). Die Wirthschafts-direction des Landgutes. 8vo. *Berlin,* 1861

HENRY DIX HUTTON, ESQ.

Thur-und Neumarkisches allergnedigst confirmirtes RITTERSCHAFTS-CREDIT-REGLEMENT. Fol. *Berlin:* 1777, 1781, 1847, 1851.

THE AUTHOR, by R. DENNY URLIN, ESQ.

Torrens (Sir Robert, M. P., K. C., M. G.), Transfer of Land by Registration of Title . . .
With the . . . Remarks of the Attorney General, Sir John COLERIDGE.

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND.

Transactions of the Highland and Agricultural Society of Scotland; . . . Fourth Series. Vol. V. 8vo. *Edinburgh:* 1873

THE NATIONAL ASSOCIATION FOR THE PROMOTION OF SOCIAL SCIENCE.

Transactions of the National Association for the Promotion of Social Science. Edited by Edwin *Pears*, LL. B., General Secretary . . .
Leeds Meeting, 1871. 8vo. *London*, 1872
Plymouth and Devonport Meeting, 1872. 8vo. *London*, 1873

THE AUTHOR.

Wendt (Ernst Emil), Papers on Maritime Legislation. With a Translation of the German Mercantile Law relating to Maritime Commerce. Second Edition. 8vo. *London*, 1871

MRS. WILLS, RELICT OF THE AUTHOR.

Wills (James, D. D., M. R. I. A. . . .), An Estimate of the antecedent Probability of the Christian Religion . . ., in six Sermons preached in . . . Trinity College, Dublin; being the Donnellan Lectures for 1858 . . . 8vo. *Dublin:* 1860

MRS. WILLS, RELICT OF THE AUTHOR.

Wills (James, D. D., M. R. I. A.), The Idolatress: and other Poems . . . 8vo. *London:* 1868

MR. H. J. FENNELL.

Woods (Thomas, M. D. . . .), Observations on the Nature and Treatment of Pulmonary Consumption. 8vo. *Parsonstown:* 1847

THE AUTHOR.

Young (Edward, Ph. D,, Chief of the Bureau of Statistics). Special Report on Immigration; . . . Information for Immigrants . . . 8vo. *Washington*, 1872.

(*Signed*)

EDW. RICHARDS PUREFOY COLLES,
Librarian.

September 9, 1873.

BOTANIC GARDEN.

MR. ANDERSON, *Nursery and Seedsman*, 22, *George's-street, Perth* :—50 kinds of very rare and new kinds of Trees and Shrubs. (A valuable donation, worth £40 at least.)

DR. JAMESON, *Superintendent Botanic Garden, Saharumpore* ;—Large parcel of the Seeds of three kinds of Palms.

The REV. DR. JOHN HALL, *Fifth Avenue Church, New York, U. S.* :— Parcel of Seeds of Wellingtonia Gigantea, direct from the big trees, California.

MR. GEORGE WHEELER, *Nursery and Seedsman, Warminster* :—3 kinds of Aquatic Plants.

DR. REICHENBACH, *Director, Botanic Garden, Hamburgh* :—38 parcels of Seeds.

DR. HOOKER, *Director, Royal Gardens, Kew* :—188 packets of Seeds.

HERR ORTGIES, *Inspector, Botanic Garden, Zurich* :—25 packets of Seeds.

DR. ELLIS, 91, *Leeson-street* :—Seeds of Nelumbium, from Cashmere.

CAPTAIN HENDERSON, 107th Regt., *Secundrabad, Madras* :—A valuable selection of Orchidaceous Plants. (*Important.*)

MR. P. J. O'SHANNESY, *Rockhampton, Queensland, Australia* :—17 kinds of Seeds, mostly new sorts.

CHARLES MOORE, ESQ., *Director, Botanic Gardens, Sydney* :—Parcels of Seeds of 7 kinds of rare Palms, from Lord Howe's Island.

PETER ROBERTSON, *Nurseryman, &c., Trinity Nursery, Edinburgh* :— 30 kinds of rare hardy Trees and Shrubs, mostly new. (*Valuable.*)

SIR DOMINIC CORRIGAN, M. R. D. S. .—3 parcels of Pine Seeds, from the Himalayas.

DR. HOOKER, *Director, Royal Gardens, Kew* :—40 kinds of rare and new Plants.

FFRENCH MACDERMOTT, ESQ. :—One rare Plant, from Africa.

M. BOUCHÉ, *Inspector, &c., Botanic Garden, Berlin* :—6 kinds of very rare Plants.

DR. HOOKER, *Director, Royal Gardens, Kew* :—One very rare Plant.

FREDERICK STRATTON, ESQ., *Newport, Isle of Wight* :—One pareel of Seeds, and two kinds of Plants.

THOMAS MACDOUGAL BLECKELY, ESQ., LL. B., M. D., &c., &c., Staff Surgeon Major, through DR. THORNHILL, M. R. D. S. :—7 parcels of ra e kinds of Seeds, from the Himalayan Mountains.

Sir Francis Brady, Bart., M. R. D. S., *Pembroke-street*:—Large parcel of Seeds of a species of Bamboo, from India.

Frederick Watts, Esq., &c., *Commissioner of Agriculture, Washington, U. S. America*, through the Foreign Office, Downing-street:—A large and valuable selection of Seeds of American Plants, containing in all 77 parcels.

John Tyreman, Esq., *Penlee, Treconey, Cornwall*:—10 kinds of rare Seeds.

David Moore, *Director, Botanic Garden*.

5th March, 1873.

NATURAL HISTORY MUSEUM.

G. N. Ferguson, 48, *Mountjoy-square*:—A mute or tame Swan, *Cygnus olor*.

Colonel Dwyer, 5, *Trafalgar-terrace, Monkstown*:—A collection of Fishing Spears, Clubs, and other implements from the Navigator Islands; Relics from Sebastopol; a Musical Instrument from the Canary Islands, &c., &c.

Rev. Edward Nangle, 26, *Belgrave-road, Rathmines*:—A Tropic Bird (*Phaëton flavirostris*).

Miss Gillespie, *Whitehall, Foxrock*:—20 species of Exotic Shells.

Christopher Fleming, M. D., 6, *Merrion-square*:—2 Eggs of Tame Swan.

Rev. B. Adams, D. D., *Cloghran, Malahide*:—Several specimens of Exotic Shells.

R. P. Williams, 38, *Dame-street*:—A specimen of the Japanese Peacock.

F. Keenan, *Chemical Works, Wicklow*:—A Cuttle-fish, *Loligo vulgaris*, taken at Wicklow.

R. Manning, 4, *Upper Ely-place*:—Animals and Honeycomb dwellings of the Worm *Sabellaria anglica*, from Kilkeel, Co. Down.

Captain A. G. Riall, R. N., *Old Conna*:—A Sparrowhawk (*Accipiter nisus*).

Lord Ventry, *Burnham House, Dingle*:—A nearly white specimen of the Curlew, *Numenius arquatus;* shot near Dingle.

M. E. Dockrell, *Eaton-square, Monkstown*:—A stuffed specimen of the Herring Gull.

DR. BATTERSBY, *Glendalough, Lough Carra*, near *Killarney*:—Fossil Shells from the South of France.

CAPTAIN KELSALL, 4, *St. James's-terrace, Clonskeagh*:—2 eggs of *Steatornis Caripensis*. Eggs of *Bulimus*, &c., &c.

SIR RICHARD GRIFFITH, BART.:—A valuable and extensive collection of Irish Fossils, from the Carboniferous and Silurian Rocks of Ireland.

REV. THOMAS ROMNEY ROBINSON, D. D., *Armagh*:—Six large specimens of *Akera bullata*, taken by the late Mr. Farran at Roundstone.

CAPTAIN KELSALL, 16*th Regiment*:—Some Birds' Skins, from Trinidad; also the egg enclosing shell of *Bulimus rosaceus*.

ROBERT N. GREENE, *Rosemount, Drumcondra*:—A complete skeleton of *Rhea Americana*.

MAJOR R. A. D. HEPPENSTAL, D. L., *Derrycassan, Granard*:—A Great Crested Grebe (*Podiceps cristatus*).

D. H. KELLY, D. L., 51, *Upper Mount-street*:—4 Birds' Skins, and the Skin of a "Native Cat," from Australia.

W. CORBET, J. P., *Castleconnell, Limerick*:—A young Emu, *Dromaius Novæ-Hollandiæ*.

REV. B. ADAM, D. D., *Rectory, Cloghran*:—Some Shells from the south coast of Africa.

ROBERT WARREN, JUN., *Moyview, Ballina*:—A Glaucous Gull (*Larus glaucus*), shot on the estuary of the River Moy.

G. V. ANDREWS, 121, *Upper Rathmines*:—A Sword with Pistol attached at the handle.

FRED. BOND, 203, *Adelaide-road, London, N. W.* (through A. G. More):—2 specimens of the Noctule Bat (*Vespertilio noctula*); 2 Field Voles; 1 Bank Vole; and 2 Tree Pipits, all collected by himself in England.

HENRY BRUEN, ESQ., M. P., *Oak Park, Carlow*:—A young Goshawk (*Astur palumbarius*).

JOHN BARKER, ESQ., M. D., 83, *Waterloo-road*:—Two specimens of Velella, from the Gulf of Siam.

MRS. BATTERSBY, *Cromlyn, Rathowen, Westmeath*:—A native specimen of Cirrhœdia xerampelina.

DANIEL CORBETT, ESQ., M. R. C. S. E., 12, *Clare-street*:—6 skeleton leaves of the *Ficus religiosa*, with Japanese figures painted on them.

NOBLE SEWARD, ESQ., M. D., *Riversdale, Templeogue*:—A Doorpost, with human figures carved on it, from Mongatap, New Zealand.

JOHN V. TRAYNOR, ESQ., 90, *South George's-street*:—A specimen of Turkey Sponge (*Spongia communis*), adhering to the rock upon which it grew.

H. R. VEREKER, ESQ., 31, *Wellington-place*:—An adult Black Tern (*Hydrochelidon fissipes*).

BASIL BROOKE, ESQ., *Colebrooke, County Fermanagh*:—A fine specimen of *Vultur monachus*, from Sardinia.

SIR D. J. CORRIGAN, BART., M. P., 4, *Merrion-square, West*:—A fine specimen of a Paradise Bird (*Paradisea apoda*).

WILLIAM CORBET, ESQ., *Castleconnell, County Limerick*:—An Iceland Falcon (*Falco islandicus*).

DR. BATTERSBY, *Glendalough, Lough Carragh, County Kerry*:—A few Insects from Cannes, France.

ALEXANDER CARTE, M. D., F. L. S., *Director*.

June 4, 1873.

INTELLIGENCE.

ROYAL DUBLIN SOCIETY'S SCHOOL OF ART.

THE DISTRIBUTION OF PRIZES.

THE annual distribution of Prizes to the Students of the School of Art of this Society took place on Tuesday evening, 25th February, at 9 o'clock.

His Excellency the Lord Lieutenant took the Chair as President of the Society. Amongst those assembled to witness the proceedings were the Countess Spencer, accompanied by Lady Victoria Spencer, Courtenay Boyle Esq., Private Secretary; Captain A. Lascelles, Captain Hutton, Aide-de-Camps, together with a large number of ladies and gentlemen, Members of the Council, of the Fine Arts Committee, and of the Society at large.

LIEUT.-COL. ADAMSON, Chairman of the Committee of Fine Arts, addressing His Excellency the Lord Lieutenant, said it had devolved on him to present the Report of the School, and also to open the proceedings. He took leave, in the name of the Committee, to thank his Excellency for his presence that night. Since his arrival in Ireland his Excellency had invariably shown to the Royal Dublin Society, and the various departments belonging to it, his patronage and kindness, and particularly to that branch which he (Colonel Adamson) had the honour unworthily to represent on that occasion. It might be necessary for him to say to many present that the Schools of this great Institution were founded 120 years ago. The Society itself was established for the encouragement of agriculture, but within a few years after its formation the Drawing Schools were added to it, and very quickly became distinguished in the education in art of the pupils attending them. In the middle of the last century the Irish Parliament granted a sum of £500 towards the support of the Schools. The grant was continued up to the period of the Union, and subsequently by the Imperial Parliament until so late as 1849, when it was withdrawn; and, after an interval of a few years, the Schools were placed in connexion with the Department of Science and Art, South Kensington. The Schools were now dependent—in one respect dependent—on the Department of Science and Art in the payments by results; but the Royal Dublin Society, in its anxiety to continue its assistance to the Schools, furnished them with a building and a grant from its private funds, and afforded various other advantages, which enabled the Schools to be continued. They must acknowledge how kind His Excellency and the Marquis of Hartington had been interesting themselves to obtain assistance for the Schools, and more particularly in the establishment of a Museum of ornamental Art, which was so much required for the instruction of the pupils of the Schools. This subject had been brought under His Excellency's attention by a deputation that had waited on him, and they still entertained a hope that their efforts in this respect would be eventually successful. Fortunately for the pupils of these Schools, during the past year a great Museum of ornamental arts sprang up in this city—he alluded to the great Exhibition, which owed its existence to the munificence of Sir Arthur Guinness, and to which His Excellency had so largely contributed Works of Art. The Pupils had derived great advantage from that Exhibition, but it was insufficient to do away with the necessity for having a permanent Museum attached to the School. Great encouragement had been given to the pupils in making designs. Various manufacturers in the city had kindly offered prizes for such. He trusted His Excellency would not consider them guilty of presumption when he mentioned that they hoped to be able to send these designs to the great forthcoming Exhibition

at Vienna. The expense connected with such an undertaking was too great to be borne by the Schools; but they would endeavour to secure the co-operation of the authorities of South Kensington. Before concluding, he must mention one pleasing feature in connexion with the Schools. There was a large number of Pupils in attendance belonging to every religious persuasion, all receiving instruction together, and living on terms of the greatest friendship and amity. He thought this showed that there must be something peculiarly humanizing in the labour which produced such excellent results. Colonel Adamson then alluded in terms of great praise to the services of Mr. Lyne, Head Master, and of Miss Julyan, Art Mistress, and proceeded to read the report of the head-master of the schools:—

REPORT OF THE HEAD MASTER OF THE SCHOOLS OF ART. FOR THE YEAR 1872.

To the Chairman and Committee of Fine Arts.

GENTLEMEN,

The operations of the Schools of Art of the Royal Dublin Society for the year ending July 31st, 1872, have, I consider, been satisfactory in a high degree, and there is evidence on all sides of the beneficial influence of the teaching of these Schools, both as regards the dissemination of right views and correct practice in Art education, and in the practice of art, both decorative and pictorial, resulting therefrom; our efforts have been much directed to the improvement of design, especially such as is more immediately required in connexion with the manufactures of this city and country. The success that has already attended our efforts is most encouraging, and I chiefly attribute such favourable results, in this and other walks of art, to our constant endeavour to impress upon the mind of the Student the fact that real success in any branch of art whatever arises from the accurate study of the higher forms of nature, and more especially of the human form.

I have to refer to the increase of Students, viz., sixty-eight for the year ending July 31st, 1872, as compared with the previous year.

A very numerous collection of works in drawing, painting, and modelling, consisting of studies by Students of both sexes and all classes (both elementary and advanced) were forwarded to London for examination in April last. Such works represented very fully and satisfactorily the general progress of the School, along with the methods of study pursued therein; and nearly every stage of the Art course was represented.

Such drawings, however, did not represent the whole of the works of such a character executed in the Schools; from various causes it was found in many cases impossible to retain such works for transmission to London.

The total number of such studies amounted to 581.

The number of Queen's prizes obtained at the National Competition on the last occasion was four, awarded as follows:—John Thomas Miles, design for table damask; J. C. Conan, anatomical study; Robert Sidney Smith, model of Antinous; Henrietta Wise, group, still life, in oil. Twenty-five of the highest prizes, or those of the "third grade," were also awarded. The very considerable number of forty-three works were selected to enter into National Competition.

The examiners of the works competing for National Awards were:—Sir M. D. Wyatt; C. W. Cope, R. A.; R. Redgrave, R. A.; F. R. Pickersgill, R. A.; J. C. Hortsley, R. A.; H. A. Bowler, Esq.; and H. Weeks, Esq., R. A.

As regards the local examination of the School in those subjects connected more immediately with elementary Art education, as freehand, practical geometry, projection, perspective, and object drawing, I have to report that eighty-six Students were successful in 134 exercises in the above named subjects. Thirty-four prizes and 100 certificates were gained, a result perhaps, on the whole, more satisfactory than has on any former occasion been attained, considering the very considerable rise in the standard that from time to time takes place.

Of full second grade, or teachers' certificates, sixteen were gained, a number exceeding that of any previous year.

The display of Students' works constituted a most interesting feature in the late Dublin Exhibition. Such studies represented the leading stages of instruction pursued in the Society's Schools, and were calculated to influence most favourably the practice of Art instruction generally, both in this city and throughout Ireland. A list of such works is appended.

The directors of the Dublin Exhibition presented free tickets of admission to many of our Students distinguished for their ability and industry, as displayed in their exhibited works (and the names of such will be found appended to this Report). These works represented the ordinary competition studies of the School.

In the Report of the Inspector General for Art, last published, the good works produced in the Society's Schools are referred to.

The evening class for female Students, established November 1st, 1872, is, I am able to report, progressing favourably, and is calculated to prove most beneficial to those whose occupations prevent their attendance upon our day classes.

Many avail themselves of the regulation enabling Pupils of public and other Schools, artisans, &c., to attend the evening classes, male and female, at reduced rates, on condition that not less than six attend from any one school or establishment.

In order to stimulate and encourage those numerous pupils of external Schools, in which drawing classes are held, in Dublin and its vicinity (classes chiefly established and organized by me during the years 1863, 1864, and 1865, and taught through the agency of the School of Art), a system of examination has been established to take place annually in the Central School. The small bronze medal of the Society, along with certificates, is given to a certain number of those who distinguish themselves by their proficiency on these occasions. When this arrangement is more widely known, it is probable that such examinations will be very numerously attended. The first examination of this kind took place on the 28th May last.

The number of Pupils of such Drawing Classes, established in Schools throughout Dublin and its vicinity, and taught through the agency of the School of Art, must, roughly estimated, amount to about six thousand.

On the 13th June last I inspected the Drawing Classes of the King's Hospital, instructed by Mr. Wm. H. Murray, Assistant Master in the School of Art.

A lending library has been recently re-established for the students; it is proposed to lend, for study at home, text-books on Art and other technicalities. The more valuable works, however, are to be consulted and referred to only in the School itself.

The organization of a class for the study of landscape and foreground detail, &c., direct from nature, occupied much of my attention during the month of July. Many promising preliminary studies were made. In connexion with this branch of study I may mention that we are greatly benefited by the fine and valuable examples of water-colour, art, &c., that we receive from time to time on loan from the Department of Science and Art.

An additional class has been very recently established,—viz., for Elementary Design for Female Students—meeting on Tuesdays and Thursdays, from ten to one o'clock. This class is open to students of all classes, on payment of a nominal fee, and it is probable that, when fully organised, it will prove highly successful.

A competition has recently taken place between the leading students of the schools generally of the United Kingdom, having for its object the selection of NINE Students qualified to make copies for the Government of the Cartoons of Raphael, with a view to preserve accurate copies of the same, and I am happy to state that one of our students, M. A. Morgan, has been successful in the preliminary test. The names of the students competing will be found appended: their works were forwarded to London on the 31st July last.

The demand for original designs executed in the Schools continues to increase, and many leading manufacturers offer money prizes for designs in various branches of industry.

During the past year the following have offered money prizes to our students, viz.:—

Messrs. Miller and Beattie, of Grafton-street, for carpet designs; Messrs. Humphries, Kidderminster, per Messrs. Sheridan, of Parliament-street, for carpet designs; Messrs. Miller and Beattie for floor cloths, &c.; Messrs. Oldham, Westmoreland-street, for table damask; Messrs. Fry, Westmoreland-street, for wall decorations; Messrs. Leetch, Dame-street, glass, &c.; Messrs. Maguire, Dawson-street, for grates, &c.

Messrs. Pim have recently produced several rich designs in figured damask, executed by our students, and others are now in progress, intended, I believe, for the Great Exhibition of Vienna.

During the past year the number of students attending the School has been 483, of which number 233 were males and 250 females.

The total number of artizan students attending amounted to 302, of which number 231 were males and 71 females.

The total amount of fees was £535 0*s.* 11*d.*

The maximum of attendance took place in the month of February, and was smallest in the month of October.

The total number of attendances during the year has been 28,119.

The Local Examinations of the second grade took place on the 25th and 26th days of May, in the evening, when 167 students, 102 males and 65 females, presented themselves for examination in the various subjects—viz., Freehand Drawing, Model Drawing, Practical Geometry, and Linear Perspective.

The Table appended shows the relative success of the male and female students in the four subjects of examination; the number of exercises "Passed," for which Certificate Cards are given, and the number of papers "Excellent," and for which prizes are awarded.

The total number of Exercises passed was 134, by 86 students.

By Male Students.

	Freehand.	Geometry.	Perspective.	Model Drawing.	Total.
Passed,	22	10	6	10	48
Excellent,	4	8	1	7	15
Totals,	26	18	7	17	63

By Female Students.

	Freehand.	Geometry.	Perspective.	Model Drawing.	Total.
Passed,	18	8	16	10	52
Excellent,	7	8	4	5	19
Totals,	25	11	20	15	71

In comparing these results with those of former years, it should be borne in mind that each year's standard has been raised, and this year considerably so in some of the subjects of study.

To each exercise passing Excellent a prize is awarded, but two or more prizes gained by the same student are represented by one award.

The following are worthy of honourable mention in [this Report, as having each passed in the whole of the four subjects of Examination on the occasion, viz.:—Edith Arnold, Annabella H. Harkness, Frances A. Rawson, Alfred W. Trevellian, and William Power; whilst the following are deserving of much commendation, as having each passed in three of the subjects, viz.:—Nannie Lee, Henrietta Lynch, John Maguire, Elizabeth Patterson, Elizabeth Robie, Wyke C. Smith.

This Examination, consisting entirely of time exercises of one hour each has for its object the testing of the ability of the student in elementary work, and such as is the

whole groundwork for advanced study in every department of Art. It is gratifying to find that students are becoming more and more impressed with the conviction that those higher results can never be worthily attained to but by the careful and patient mastery of those preliminary branches.

The following gentlemen, members of the Council and of the Fine Arts Committee, attended during the Examination:—Colonel Adamson, George Johnstone Stoney, Esq., David Routledge, Esq., John Du Bedat, Esq., Denny Urlin, Esq., Thomas Berry, Esq., Captain Harvey, R. E.

In April the Works of the Students, in Painting, Drawing, and Modelling, were forwarded to the South Kensington Museum, to compete for National and other medals, as follows;—

In the Elementary Section, ...	41 Works.
In the Advanced Section, ...	185 Works.
Class Drawings, consisting of Geometry, Perspective, Projection Models, Ornament, Figure, &c., ...	347 Works.
Books, ...	8 Works.
Total,	581

To the works competing for the highest prizes, or those of the 3rd grade, 25 awards were made to 22 students.

The following Table represents the position occupied by the Dublin School, as regards the numbers successful in 2nd grade examinations, in gaining 2nd grade prizes, and obtaining the 3rd grade awards, as compared with the Metropolitan Art Schools of London:—

	2nd Grade Examination. No. Successful.	2nd Grade. Prizes.	3rd or Highest Grade Prizes.
South Kensington, . .	103	42	37
Dublin, ...	86	27	25 to 22 Students.

On the 11th and 15th March last, the Honorary Professor of Fine Arts, Henry M'Manus, Esq., delivered two lectures on "Design as indispensable to a high condition of Fine and Ornamental Art," which were attended by 229 persons.

The competition for the Bronze and Silver Medals offered by the Royal Dublin Society took place on the 21st of December, the examiners upon that occasion being—Evory Kennedy, Esq., M. D., Chairman of Fine Arts Committee; Thomas Alfred Jones, Esq., P. R. H. A.; Thomas N. Deane, Esq., R. H. A.; Henry Doyle, Esq., Director of the National Gallery, Ireland, A. R. H. A.; and James Edward Rogers, Esq., A. R. H. A. Their Report is appended.

At the recent Exhibition of Students' Works, open from the 26th of December to the 9th of January, 1873, the visitors numbered 5150.

His Excellency the Lord Lieutenant and the Countess Spencer also visited the Exhibition.

During the year many works executed in the School by our students have been purchased by manufacturers, and amongst others, I may mention a design by Mr. E. R. Byrne, purchased by Messrs. Mitchell, of Parliament-street, to be produced in stamped velvet.

A design by Miss S. Ball (carpet), to be produced by Messrs. Lewis, the eminent carpet manufacturers of Halifax, Yorkshire.

A design—Rich Damask Hanging—by Miss F. L. Jordan, produced by Messrs. Pim; and also a design by the same for flowered silk dress, manufactured by Messrs. Pim.

Rich Table Damask, by Miss M. L. L. O'Clery, to be produced by Messrs. Oldham, Westmoreland-street.

Rich Table Damask, by Mr. F. T. Miles—by Messrs. Brown, of Belfast.

Wall Decoration, by Miss E. Kerr—by Messrs. Fry, Bachelor's-walk.

Carpet Design, by Miss M. F. Murphy—by Messrs. Miller and Beattie.

Carpet, by Miss M. Irwin—by Messrs. Humphries, of Kidderminster, for Messrs. Sheridan.

Four rich-figured Damasks, from designs by Miss S. Ball; and a flowered Silk Dress design, manufactured by the Messrs. Pim.

Landscape, in oil—Scene on the Dargle—by Miss M. D. Webb, purchased by Mr. Rothwell.

Design by Miss E. Irwin—Carpet and Border—produced by Messrs. Sheridan, of Parliament-street.

Plate designs by Miss F. Brett and Miss E. Bredin, produced by the Messrs. Wedgwood for Messrs. Leetch, of Dame-street.

Messrs. Miller and Beattie offer prizes of £7 and £5 for the two best designs for Brussels carpets.

Messrs. Leetch, of Dame-street, offer a prize of four guineas for the best design for a glass centre-piece for a dining table.

Messrs. Maguire offer a prize of three guineas and of one guinea for the first and second best drawings, being original designs, for a grate, tiled hearth, and fender (*en suite*) suitable for a modern mansion, in the early decorated style of architecture, and as simple in treatment as this style will admit of.

The offer of such prizes affords evidence of the manner in which these Schools are acting upon the productions of the country, and we receive numerous acknowledgments from manufacturers and others as to their value in connexion with Art industry.

The Worshipful Company of Plasterers of London offer money prizes to be competed for by students of School of Art, as follows:—

1. For an original design for a spandril, modelled in low relief, the filling-in to consist of an arabesque combination introducing the figure, fruit, foliage, flowers, or other ornamental motives.

The spandril to fill the space between two adjacent arches, and to be enclosed in mouldings. The curves of the arches to be at the choice of the designer. Any style may be chosen. The size of the model not to exceed 30 inches by 24 inches.

For the best, ...	£7	7	0
,, second best, . . .	£4	4	0

2. For an original design drawn in pencil or in monochrome, and capable of being executed in plaster in low relief, for the decoration of a chimney-breast from floor to ceiling, including a chimney-piece, the decorative treatment of the space above, and cornice.

The drawing to be 24 inches high; the scale to be stated.

For the best, ...	£8	8	0
,, second best, . . .	£5	5	0

Designs to be sent in on the 10th April, 1873.

The Lords of the Committee of Council on Education, being desirous of preserving accurate copies of ancient wall paintings in churches or other old buildings previous to the sixteenth century, have decided to offer prizes of £5, £3, £2, and £1 for successful copies of such paintings made by students of Schools of Art, with the condition that the Department of Science and Art shall have the right of purchasing such copies at prices to be fixed by the Inspector-General for Art.

Two students of the School have been intrusted with the production of the perpetual Challenge Cups for the Irish Champion Athletic Club. Such Cups are to take the form of Bronze Statuettes of the most famous of the Grecian athletic statues, such as Discobolus, Athlete with Strigil, Fighting Gladiator, &c., &c. For the modelling of these, two of the leading students of the Society's School have been selected—viz., Mr. Robert Sidney Smith, and Mr. Edward Gibson.

I have to acknowledge the valuable assistance rendered by Miss Mary Julyan, in the instruction of the female classes.

My thanks are also due to my assistants, Mr. Edmond Ribton Byrne, Mr. William H. Murray, Mr. Robert Walsh, and Miss M. A. M'Gee.

It is encouraging to find that there is a steadily increasing demand for design evidencing intelligent motive as distinguished from the unmeaning productions still too common, and this improved taste on the part of the public generally makes it evident to all, and especially to the manufacturer, that Art culture is a necessity, and that all concerned must, by study, gain an insight into those laws and principles of Art which apply equally to every style, whether of the past or the present. It is to be regretted that an erroneous idea prevails so largely, that an absolute division exists between industrial and fine art; such a view cannot but be prejudicial to the development of artistic manufacture.

It cannot be too often reiterated that true decoration is the offspring of high art, and that ornamentation, even as applied to the most common things in daily use, in order to be thoroughly successful, requires a cultivated taste, and the knowledge to adapt the beautiful in nature, and to combine forms of permanently recognised beauty, which, regulated by a few elementary principles, results in an embodiment of the artistic mind, and appeals to the sentiments of the age.

The ability evident in the highest art developments of any country or period is not so much the direct consequence of a higher order of intuitive ability, greater than possessed by our own race, but may rather be referred to the combined and continued influences of the generally elevated standard of Art labour at those periods.

The subject of Art Education, as distinguished from the merely desultory practice of so-called drawing, is a matter to which the attention of all concerned may be profitably directed. The necessity, on the part of those interested, of acquiring a knowledge of the subject calculated to advance and promote Art in its various departments, cannot be too strongly urged. The absence of such knowledge of the right practice of Art, and lack of that workmanlike ability so indispensable in all productions of a high character, along with ignorance of those principles which are guides to inventive talent, must result only in triviality and vulgarity; for in order to render common things rare, by the instrumentality of Art, the faculties must be cultivated and refined by long and intelligent study.

The present position and prospects of the School are most encouraging, and as regards fees and attendance, I am happy to state that there is every prospect of increase over former years. In concluding this Report I may remark upon the effect produced by this School's teaching of late years, not on manufacturers only, but also the great influence it has exercised in forming a more healthy taste throughout the entire community.

These Schools have also served to give the initiative as regards Art instruction, and their influence and example has been and is leading to the adoption, generally in this city and country, of a more consistent, thorough, and logical system of instruction and study.

(Signed) EDWIN LYNE, Head Master.

February 10*th*, 1873.

His Excellency then proceeded to distribute the Prizes to the several Students, the list of which is as follows:—

ROYAL DUBLIN SOCIETY'S PRIZES.

SPECIAL SILVER MEDAL,

OFFERED TO THE ASSISTANT ART TEACHERS FOR THE BEST DESIGN IN DAMASK.

Names.	Prizes.
Robert Walsh, for Design for Damask, ...	*Special Silver Medal.*

CLASS I.

SECTION 1.

Studies of the Human Figure.

Names.	Prizes.
L. Langan, for Drawing of Jason, in Chalk, ...	*First Silver Medal.*
P. A. Moss, for Drawing of the Adonis of the Vatican, in Chalk, ...	*Certificate.*

SPECIAL SECTION.

Edward Gibson, for Three Sheets of Pencil Sketches from Nature, ...	*Special Certificate.*
J. O. Tobias, Illustrations of Faerie Queen	*Much Commended.*
J. T. Miles, Head of Female, from Beautiful Gate of the Temple of Raphael, Copy in Monochrome, . . .	*Special Certificate.*

SECTION 2.

Edith Arnold, for Studies of Heads, in Oil, from Life, . .	*First Silver Medal.*
P. A. Moss, for Studies of Heads, in Oil, from Life, recommended for Colour, ...	*Commended.*
A. Parnell, for Female Heads, in Oil, from Life, . . .	*Special Certificate.*
M. D. Webb, for Female Heads, in Oil, from Life, . .	*Highly Commended.*

SECTION 3.

Edith Arnold, for Chalk Studies of Head, Hand, and Foot, from the Antique, in Chalk, ...	*Second Silver Medal.*
A. Parnell, for Monochrome Oil Studies of Head, Hand, and Foot, ...	*Certificate.*

SECTION 4.

Kate O'Brien, for Low Relief of Germanicus, ...	*First Silver Medal.*
Edward Bestick, for Bust of Female, from Nature, . .	*Certificate.*
Robert S. C. Smith, for Statuette of Antinous, and Female Head, from Life, ...	*Special Certificate.*

SECTION 5.

Harriet Thornhill, for Anatomical Studies, ...	*Second Silver Medal.*
Mary A. Bredin, for Anatomical Studies, ...	*Certificate.*

SECTION 6.

Harriet Hanlon, for Outline of Hercules, from the Flat, . .	*First Bronze Medal.*

CLASS II.

SECTION 2.

S. Colclough, for Original Design for Iron Gates, ...	*First Bronze Medal.*
Charles Allen, Original Design for Iron Gates, ...	*Certificate.*

SECTION 3.

H. J. Monks, for One Sheet of Geometry, ...	*Second Bronze Medal.*
J. Kirkwood, for One Sheet of Geometry, ...	*Certificate.*
Lizzie Robie, for One Book of Geometry, ...	*Certificate.*

SECTION 4.

Names.	Prizes.
Miss Isabella Campbell, for One Sheet of Perspective, .	*Second Bronze Medal.*
Florence Walker, for One Book of Perspective, . . .	*Second Bronze Medal.*
Bessie Birch, for One Book of Perspective, ...	*Certificate.*

SECTION 5.

W. H. Mackenzie, for Sheet of Orthographic Projection, .	*Second Bronze Medal.*
H. J. Monks, for One Sheet, Orthographic Projection, .	*Certificate.*

SECTION 6.

William Gilligan, for Tracing from Roman Architecture, .	*Special Certificate.*

CLASS III.

SECTION 1.

Ismima Benson, for Group (Still Life), in Oil, ...	*First Silver Medal.*
Mary Weld, for Group (Still Life), in Oil, ...	*Certificate.*

Paintings in this Section Highly Commended.

SECTION 2.

John Campbell, for Group of Models, in Chalk, . . .	*First Bronze Medal.*
Mary E. Hawkins, for Group of Models, in Chalk,. . .	*Certificate.*

CLASS IV.

SECTION 1.

E. R. Byrne, Assistant Teacher, for his Set of Oil Landscape Studies, ...	*Special Cert. recommen.*
M. D. Webb, for Sketch in the Dargle, with Rocks in foreground, ...	*First Silver Medal.*
Olivia Poole, for Sketch in Rathfarnham Park, . . .	*Certificate.*
M. Benson, for Sketch of Crinkaleekeen, Co. Donegal, . .	*Special Certificate.*
Wm. Le Fanu, for Set of Landscape Studies, . . .	*Certificate.*

SECTION 2.

Harriette Thornhill, for two Sheets of Flowers, from Nature, .	*Second Silver Medal*
E. Kerr, for two Studies of Flowers, from Nature, . .	*Certificate.*

SECTION 3.

Lizzie Naylor, for one Sheet of Foliage, from Nature, .	*First Bronze Medal.*
C. Mitchinson, ditto, ditto, . . .	*Certificate.*

CLASS V.

SECTION 1.

W. A. Maguire, for Trajan Frieze, in Outline (enlarged), .	*Second Bronze Medal.*
Alice Adair, Tarsia, in Outline (enlarged), ...	*Certificate.*

SECTION 2.

Names.	Prizes.
Dora Bradley, for Ornament shaded, from the Flat, in Chalk, ...	*First Bronze Medal.*
A. O'Hanlon, for Roman Scroll, do. do. . .	*Certificate.*

SECTION 3.

M. A. Bredin, for Outline Ornament, from the Round, . .	*Second Bronze Medal.*

SECTION 4.

Clara Barnes, for Apples shaded in Chalk, from the Cast, .	*First Bronze Medal.*
Lizzie Robie, for Plums shaded in Chalk, from the Cast, .	*Certificate.*

CLASS VI.

SECTION 1.

M. Irwin, for Design for Carpet (Brussels), ...	£7 0 0
John T. Miles, for Design for Carpet (Brussels), ...	3 0 0

[These prizes were offered by the Messrs. Humphries, of Kidderminster, per Messrs. Sheridan of Parliament-street, Dublin.]

SECTION 2.

M. F. Murphy, for Design for Brussels Carpet (Boudoir), . .	£3 0 0

[This prize was offered by Messrs. Millar and Beatty, of Grafton-street, Dublin.]

SECTION 3.

F. L. Jordan, for Messrs. Millar and Beatty's prize for best Design for Oil-cloth, ...	£3 3 0
M. A. Magee's Design for Oil cloth, ...	*Certificate.*

SECTION 4.

L. M. M. O'Cleary, for Design for Damask Table Cloth, . . .	£3 3 0

[This prize was offered by Messrs. Oldham, Westmoreland-street, Dublin.]

SECTION 5.

E. Kerr, for Design for Wall Paper, ...	£2 2 0

[This prize was offered by Mr. William Fry, Bachelor's-walk, Dublin.]

F. L. Jordan, Design for Wall Paper, ...	*Certificate.*

MISCELLANEOUS DESIGNS.

SECTION 6.

F. L. Jordan, for Design for Irish Point Lace (Flounce), .	*Certificate.*
F. Scott, for Design for Inlaid Panel, ...	*Certificate.*
Frances Brett, for Design for Compotier, ...	*Certificate.*
Susan Ball, for three Designs for Furniture Damask (Manufactured), ...	*Special Certificate.*
Elizabeth Irwin, Carpet (Manufactured), ...	*Special Certificate.*

CLASS VII.

SECTION 1.

Names.	Prizes
C. Benson, for Copy of Picture by Hassan Plug (Cloisters),	*Special Certificate.*
C. Benson, for Copy of Picture by Carrick, ...	*Special Certificate.*

The following is a copy of the Report of the Judges of Works of Art Students, December, 1872, by whom the foregoing prizes were awarded:—

WE have carefully examined the works submitted for our inspection this year in the Art School of the Royal Dublin Society, and are able to report most favourably on their general merits, and congratulate the Society on this very interesting Exhibition, which fully equals, if it does not excel, those of former years. The average amount of ability displayed in these specimens shows a decided advance, and their very much increased numbers bear testimony to the application and zeal of the students.

In several instances the merits of the competing works were so evenly balanced, that considerable difficulty was experienced in awarding the prizes. This, in our opinion, bears the highest testimony to the efficiency of the instruction given in these Schools, and the ability and careful superintendence of the Head Master, Edwin Lyne, Esq., and the Assistant Teachers under him.

We have been most favourably impressed by the genuine artistic promise shown in a Study of a Female Head from Life, and a Statuette of Antinous, by Mr. Robert S. C. Smith, and in three sheets of Pencil Sketches by Mr. Edward Gibson. We have also awarded a Special Certificate to Miss A. Parnell, for a Study of a Female Head in Oil, and one to Mr. William Gilligan, for some remarkable tracings from Architectural Engravings.

The works exhibited under Class 4 (the best Landscape from Nature, in Oil or Water-colours) exceed in number any previous display, and many of them show a refined appreciation of Nature's effects, and a marked improvement on those of former years.

In Class 6, Designs for Manufactures, the present Exhibition creditably maintains the deserved reputation which our Students have gained in this department. The number of valuable prizes offered by eminent manufacturers in England and Ireland affords a pleasing recognition of the talent and originality displayed in the designs produced here; and we are surprised that the considerable sums offered for Designs for Carpets did not produce a keener competition. We cannot, however, close our Report without recording the extreme satisfaction it gives us to be enabled to inform the Society, that fabrics already manufactured from the designs of our Students have met with general approval; and we have much pleasure in drawing marked attention to the Furniture Damasks produced by the Messrs. Pim, from the graceful designs of Miss Susan Ball, and the Carpet and border, made at Kidderminster, for the Messrs. Sheridan, of Parliament-street, designed by Miss Elizabeth Irwin. In both instances the manufactured articles have been granted Silver Medals, at the recent Great Exhibition of Arts and Manufactures, held at the Exhibition Palace. This practical illustration of the success which attends careful study must act as an incentive to the Students, and encourage the Head Master to persevere in the conscientious discharge of his duties.

(Signed) EVORY KENNEDY,
THOMAS ALFRED JONES, P. R. H. A.
THOMAS N. DEANE, R. H. A.
JAMES EDWARD ROGERS, A. R. H. A.
HENRY DOYLE, A. R. H. A.

December, 1872.

PRIZES AWARDED BY THE DEPARTMENT OF SCIENCE AND ART.

NATIONAL AWARDS, 1872.

Name of Student.	Stage.	Subject.	Prize.
Conan, J. C., . .	9a	Anatomical Study, ...	Queen's Prize.
Miles, J. T., . .	23c	Design for Damask, ...	Book. Do.
Smith, R. S., . .	19b	Cast from Antique, ...	Do.
Wise, Henrietta, .	15	Group in Oil, ...	Do.

SELECTIONS FOR NATIONAL COMPETITION.

Students' Names.	Stage.	No. of Works.	Subject.
Arnold, E. M. . .	8b(1), 17b	2	Foot of Laocoon shaded in Chalk. Head from the Life in Oil.
Brett, Frances M. .	23c(3), 23d(2)	5	Design, original, for Compotier, and Plate Design (Arbutus border). Design, original, for Table Damask. Do. Plate Design (Chrysanthemum border).
Irwin, Elizabeth, .	23c, 23d	2	Original Design for Table Damask. Plate Design (2) one Sheet.
Irwin, Marcella, .	23c(2)	2	Original Design for Table Damask. Do. do.
Kelly, Joseph, .	19d	1	Head of Juno, modelled from the Antique
Miles, J. T., . .	23c(2), 23d	3	Wall Decoration (Design). Table Damask (Design). Plates (2 Designs) one Sheet.
Moss, Phebe A., .	8b 1, 8b 2	3	Discobolus shaded in Chalk from Antique. Head of Alexander (dying) in Chalk from Antique.
Magee, Mary A., .	23c	1	Wall Decoration (Design).
Maffett, Isabella, .	23d	1	Plate Design.
Morgan, Marianne, .	17b	1	Head from the Life in Water Colour.
M'Gee, M. A., .	15a	1	Group, still Life from Nature in Water Colour.
Naylor, Eliza, . .	14a	1	Foliage from Nature in Water Colour (Arbutus).
Nicholson, Ruth, .	23d	1	Plate Design.
O'Brien, Kate J., .	19d	1	Female Head modelled from the Life (Farnese Hercules).
Parnell, Anna, .	17b, 8b 1, 8b 2	3	Female Head painted from the Life in Oil Colour. Head of Barbarian Chief shaded in Chalk. Discobolus of Myron, shaded in Chalk, from the Antique.
Smith, R. S., . .	19d, 19b	2	Antimon, modelled from the Antique. Bust of Milo Venus modelled from Antique.
Tobias, J. D., .	1d	1	Head of Juno modelled from the Antique.
Wallace, E., . .	15a, 23c(2)	3	Lace Design (Original). Group, still Life from Nature, in Water Colour. Original Designs for Table Damask.
Walsh, R. F., . .	14b	1	Landscape, from Nature in Oil Colour.
Wise, Henrietta, .	15a	1	Group, still Life, painted from Nature in Oil.
Jordan, Frances, .	23c	1	Lace Design for Flounce.
Thornhill, H., . .	9a	1	Skulls from Nature in Water Colour.
Conan, J. C., . .	9a(2)	2	Skeleton from Nature in Water Colour. Skulls from Nature in Water Colour.

THIRD GRADE PRIZES.

Highest Prize is marked (P 2).

Students' Names.	Prize.	Stage.	No. of Works	Subject.
Arnold, Edith M.,	P 2	8*b*, 1, 17*b*	2	Foot of the Laocoon, shaded in Chalk from the Cast. Head of Female, painted from the Life in Oil.
Brett, Frances M., I.	P 2	23*c*	1	Original Design for Plate, Arbutus pattern, manufactured by Miss Wedgwood.
Bergin, Isabella,	P 2	5*a*	1	Group of Objects from the round, in Chalk.
Kerr, Eleanor,	P 2	5*a*	1	Group of Objects from the round, in Chalk.
Kelly, Joseph,	P 2	19*d*	1	Head of Juno, modelled in Clay.
Moss, Phebe A.	P 2	8*b*, 1	1	Head of Dying Alexander, shaded from the Cast in Chalk.
Morgan, Marianne,	P 2	17*b*	1	Head of Female, painted from the Life in Water Colour.
M'Gee, Mary A.,	P 2	15*a*	1	Group, still Life, painted from Nature in Water Colours.
Naylor, Eliza,	P 2	14*a*	1	Branch of Arbutus, painted from Nature, in Water Colours.
O'Brien, Kate J.,	P 2	19*b*	1	Farnese Hercules, modelled from the Antique.
Parnell, Anna,	P 2	17*b*, 8*b*, 1	2	Female Head, painted from the Life in Oils. Head of Barbarian Chief, from the Antique, in Chalk.
Smith, R. S.,	P 2	19*d*	1	Bust of Milo Venus, from the Antique.
Tobias, J. D.,	P 2	19*d*	1	Head of Juno, modelled from the Antique.
Wallace, Elizabeth,	P 2	15*a*	1	Group with Brambles and Birds' Nest, in Water Colours.
Weld, Mary,	P 1	4*b*	1	Two Panels, Ornamental, shaded from the Flat, in Chalk.
Jordan, Frances,	P 2	23 *c*	1	Original Design for Lace Flounce, Anemone and Wild Pea.
Thornhill, H.,	P 2	5*b*, 9*a*	2	Plum Branch, from the Cast, shaded in Chalk. Two Studies of Skull in Water Colours, from Nature.
Bradley, D.,	P 1	4*b*	1	Roman Column, shaded in Chalk.
Bucknall, S.,	P 1	6*a*	1	Outline of Laocoon enlarged.
Dundas, O.,	P 1	4*b*	1	Column with Ivy Ornament, in Chalk.
Murphy, M. F.,	P 2	3*b*	1	Madelene Pilaster, from the Cast in Outline.
Wharton, Julia, J. E.,	P 1	4*b*	1	Column with Ivy Ornament, in Chalk.

SECOND GRADE PRIZES.

List of Students who have been successful.

Name.	Nature of Examination.				Prize Selected.	Full Certificate.
	Free-hand.	Geometry.	Perspective.	Model.		
Arnold, Edith M.,	E	E	E	E	Colours.	Certificate.
Birch, Bessie,	E	..	..	..	Wornam's Ornament, and Lindley's Botany.	

P signifies Passed, and entitles the Student to a Certificate Card. E signifies Excellent, and entitles the Student to a Prize.

Name.	Nature of Examination. Free-hand.	Geometry.	Perspective.	Model.	Prize selected.	Full Certificate.
Boyle, James T., . .	E	..	..	..	Instruments.	
Burns, William S., .	..	E	..	..	Pucket's Sciography.	
Graydon, Herbert P.,	..	..	..	E	Instruments.	
Harkness, Mrs. A. H.,	E	E	P	P	Burchett's Geometry and Perspective.	Certificate.
Hawkins, Mary E., .	E	..	..	E	Colours.	
Lee, Alice E., . .	..	..	E	P	Colours.	
Lee, Nannie, . .	P	P	..	E	Colours.	
Le Fanu, George B., .	P	..	..	E	Colman's Pencil Outlines.	
Lefroy, Helena . .	E	..	..	..	Colours.	
Lynch, Henrietta, .	E	..	P	E	Colours.	
Maguire, John, .	P	P	..	E	Instruments.	
Millard, B., . . .	E	P	..	..	Instruments.	
Millard, Joseph, . .	..	..	P	E	Instruments.	
Oliver, Mary, . . .	..	E	..	..	Burchett's Perspective.	Certificate.
Power, William, . .	P	P	E	P	Instruments.	Certificate.
Patterson, Elizabeth, .	P	..	E	P	Wornam's Ornament, and Lindley's Botany.	
Rawson, Frances A.,	E	P	P	E	Instruments.	Certificate.
Robie, Elizabeth J., .	P	P	E	..	Instruments.	
Ruddle, Marcus, .	..	E	..	..	Burchett's Perspective.	Certificate.
Smith, Wyke C., .	P	E	..	P	Burchett's Perspective.	
Spingler, Gustave, .	..	..	..	..	Crayons.	
Trevelyan, A. W., .	P	P	P	E	Colours.	Certificate.
Walker, William R., .	E	..	..	..	Instruments.	
Waters, Thomas, .	..	..	..	E	Colours.	
Yates, George, . .	P	..	..	E	Instruments.	
Archdall, Alice, . .	..	..	..	P		Certificate.

P signifies Passed, and entitles the Student to a Certificate Card. E signifies Excellent, and entitles the Student to a Prize.

Name.	Nature of Examination.				Prize Selected.	Full Certificate.
	Free-hand.	Geometry.	Perspective.	Model.		
Conan, Jeanie C., .	..	..	P	..		Certificate.
Dundas, Olivia, .	..	..	..	P		Certificate.
Knox, Henrietta, .	P	..	..	P		Certificate.
Lalor, Mary C., . .	..	..	..	..		Certificate.
Murphy, M. F., . .	..	..	P	..		Certificate.
Naylor, Elizabeth, .	..	..	P	..		Certificate.
Pigott, Matthias, .	..	P	P	..		Certificate.
Thornhill, H. A. M.,	..	..	P	..		Certificate.
Adair, Alice, . . .	P	..	..	..		
Adams, Stephen, . .	..	..	P	..		
Allen, Thomas. . .	P	..	..	..		
Alexander, Anna M. M.,	..	P	..	..		
Armstrong, Lavinia, .	..	P	..	P		
Ball, Annie F., . .	P	..	P	..		
Brown, Alexander, .	P	..	..	P		
Campbell, Isabella S.,	..	..	P	..		
Campbell, John, .	P	..	..	..		
Church, Lillie E., .	P	..	..	..		
Collins, Jane E., .	..	..	P	..		
Collum, Mary A., .	..	..	..	P		
Corbet, Thomas, .	P	..	..	..		
Cox, Sylvester, .	P	..	..	..		
Cromien, Arthur, .	P	..	..	P		
Cuthbert, Edward F.,	P	P	..	..		
Fellows, Mrs. M. A., .	P	..	P	..		
Foot, C. Anne, . .	P	..	..	..		
Foster, Florence A., .	P	..	..	..		
Frizell, W. H., . .	..	P	..	..		
Fry, Marion, . . .	..	P	P	..		
Gibbs, Bessie M., . .	P	..	..	..		
Jordan, F. L., . . .	..	..	..	P		
Keane, L. C., . . .	..	..	P	..		
Kerr, Eleanor, . . .	..	P	..	P		
Kirkwood, John J., .	P	..	..	..		
Lynch, Lawrence J., .	..	P	..	..		
Mackenzie, William H.,	P	..	..	..		

P signifies Passed, and entitles the Student to a Certificate Card. E signifies Excellent, and entitles the Student to a Prize.

Names.	Nature of Examination.				Prize Selected.	Full Certificate.
	Free-hand.	Geometry.	Perspective.	Model.		
Maguire, William A.,	..	P	..	P		
Moore, Marian, .	P	..	..	..		
O'Sullivan, William,	P	..	..	..		
Poirotte, T., . . .	P	..	..	..		
Poland, Charles, . .	P	..	..	..		
Rafter, Patrick, . .	P	..	..	P		
Shaw, Bernard, . .	..	P	..	..		
Shaw, George, . .	..	..	P	..		
Sheridan, P. J., . .	P	..	..	..		
Smith, Frances, . .	..	..	..	P		
Smith, J. L. M., . .	P	..	..	..		
Smith, J. C., . . .	..	..	..	P		
Smith, N. C., . . .	P	..	..	..		
Smythe, Frances, . .	P	..	..	..		

P signifies Passed, and entitles the Student to a Certificate Card. E signifies Excellent, and entitles the Student to a Prize.

Four Bronze Medals and Certificates offered to Pupils of Drawing Class in Dublin, for success in Time Free-hand Exercises.

BRONZE MEDALS.

Annie Palmer, John Fagan, Annie Johnston, G. F. Yeates.

Certificates.

Louisa Sandys, William H. Gamble, John Shaw, Emily Lunn, Henry Simmonds, Joseph Walter Scott, Benjamin William Parke, Thomas Parke.

Lieut.-Col. Adamson then proposed a vote of thanks to the Judges of the Works executed in competition for the Society's Prizes:—Dr. Evory Kennedy, Thomas Alfred Jones, President of the Royal Hibernian Academy, Thomas M. Deane, R. H. A., James Edward Rogers, A. R. H. A., and Henry Doyle, A. R. H. A.

T. A. Jones Esq., P. R. H. A., in acknowledging the compliment on behalf of himself and his colleagues, bore testimony to the increased industry of the Students, and the energy and efficiency of Miss Julyan the Art Mistress, Mr. Lyne the Head Master, and to

the Pupil Teachers. The ladies, he was happy to say, had carried off most of the prizes. He had acted for many years as a Judge, but he never observed that so large a number of works had been previously submitted in competition in one year, as were exhibited upon the present occasion. He wished to refer specially to the models of Mr. Robert Catterson Smith, who bade fair to perpetuate the fame of an illustrious sire, and to the sketches of Mr. E. Gibson, as showing very great artistic promise.

SIR RICHARD GRIFFITH, BART., Vice-President. then proposed a vote of thanks to His Excellency the Lord Lieutenant and the Countess Spencer, for their kindness in attending on the occasion, and for the interest that their Excellencies have always manifested in the Schools.

His Excellency, in reply, said—Ladies and gentlemen, I thank you very sincerely for the kind manner in which you have received the Resolution just proposed by Sir Richard Griffith. It always gives me very great pleasure and satisfaction to be present on the interesting occasion of the distribution of Prizes at the Dublin Society's Schools. The observations that we have heard from Colonel Adamson, and the extracts which have been read from the reports on these Schools, leave very little for me to address you upon to-night; but I will endeavour to make a few remarks, and I promise you they shall be very few. On the last occasion I was glad to observe that the name of one who had been very distinguished in Dublin was coming up among those who received Prizes at your Society—I was glad to see him prominent again here to-night; but I cannot, when alluding to his name, omit to express my deep regret at the loss which the followers of Art have had in Dublin by the much regretted death of Mr. Catterson Smith. Mr. Catterson Smith was well known as a distinguished artist, not only in Dublin and Ireland, but also in England. I had the pleasure of knowing him years ago in England, and have had to thank him for two admirable portraits which I now possess in England. He was very distinguished as a portrait painter, and I am sure he did much in this Society by the encouragement which he gave to all Students of Art. The Society, I am sure, owes him a great deal, and it must have been a matter of great satisfaction to you to hear the eulogistic terms in which the President of the Royal Hibernian Academy spoke of the rising talent of a son of Mr. Catterson Smith. Colonel Adamson, in his address, referred, in very excellent terms, to the advantage which Dublin, during the past year, has obtained by the Exhibition under the auspices of Sir Arthur Guinness. I have before now alluded to the great importance which a good Museum has on the encouragement of Art and Industry. The Exhibition held last year tends to prove that, and I believe that very great benefit will have been derived thereform by Art Students in the city. I will now only speak of one department in the Exhibition—the Art department—which, I am sure, must have been a boon to those studying in these Schools. We found there magnificent statues in marble by the most distinguished sculptors of Italy and England, and great benefit must have been derived from a study of these models. Again, looking at the pictures, we found a very fine collection from the ancient and modern masters. I might, perhaps, express some little regret that those who had the selection of those pictures were not a little more severe in their rejection of some. It is a very difficult task, I know, to reject the property of those who were kind enough to offer contributions; but it would, nevertheless, have been more satisfactory if only works of the very highest merit were accepted at exhibitions of the kind, so that those who went there would not have to select between moderate and excellent works, or original works, and works supposed to be copies. But, as I have said, that is a very difficult thing to effect, and I do not for a moment blame the gentlemen who had the management of that very successful exhibition, for their acceptance of works offered to them, though I still think it would be most advantageous if greater severity were exercised in selection. But if we turn to another part of the Exhibition, or rather of the same department, we could hardly find there anything but an admirable example of merit—I refer to the portrait gallery. There, I believe, there was nothing to find fault with; each exhibit was a work of art, or interesting as an historical recollection it awakened of persons known in Irish History. On those walls were hung side by side the portraits of great soldiers, statesmen, poets, painters, players, and a host of others. All were to be seen,

their features were to be learned, and much to be gathered of the genius of past men. We learned there, in a word, how much we owe to portrait painting, and I am sure everybody who visited that department will have gained something—will have added to their knowledge of history some new conception as to the great men whose words and actions may have been known, but whose presence and features were unknown. I dare say many took a different view of some characters they previously regarded as base and bad, and that others may have formed a more severe view of favourites they had in history. On the whole, I think that it is a very important work for painters in this country thus to assist the history of the great men in this country. It was not only in that way that we derived advantage from the exhibition; but in observing the habits, the customs, and even the costumes of the generations gone by, we have also been much inrerested; that, too, forms another and not unimportant branch of the portrait painter's duty. Many may have been astonished at the curious dresses and long curls of the ladies of the past, as represented there; but the painters of the present day have also a task to perform in depicting to future generations the large chignons and high heels that are all now in fashion among the ladies who move amongst us. I think that all those duties are very important. Really, I am not jesting on the subject. I think they are very important duties for the portrait painters who now occupy the positions which Lawrence, Reynolds, and Gainsborough did some time ago. In speaking of pictures and sculpture, I must not be supposed to imply that I think a School of Design is less important than a School of high Art. I believe that the School of Design is very intimately connected with the School of high Art, for, wherever we find high Art in painting or in sculpture prevailing, we almost invariably find excellent taste prevailing in all manufactures. Where is it that we now go for good specimens of hangings, furniture, plate, or any other manufacture, in which taste is required? Why, it is to Spain, or Italy, or France, or Germany. And to what period do we look for the best specimens of those arts? To the period when Velasquez, and Mignat, and Holbein, and Raphael, were at the zenith of their fame. I am glad to hear from those who have spoken before of the number of Prizes that have been given by manufacturers to those Schools of Design. I have heard on former occasions of this happy result of the Schools of Design, and I am glad to be able to-night to congratulate the Dublin Society on the large increase of those who have, during the past year, come to its Schools for designs. It is, I must say, a result—a very practical result—which must be satisfactory to all parties interested in their welfare. Not only do manufacturers come here for good designs, but I was happy to read this morning that an athletic society have also resorted hither to ask models for Prizes, which they intend offering to those who compete at their sports in the course of the present year. That, I think, is an admirable example to have set; for, now that we have so many prizes of different sorts given in the United Kingdom, it is well that an endeavour should be made to obtain the best possible designs for them. I see here models, on either side, supplied by two of your pupils, for the Society to which I have alluded, and I think they show excellent merit, and will reflect credit both on these Schools and on the association which has elected to offer such awards. I referred in my opening remarks to the importance of a Museum of Art, and it is not the first time I have spoken of that here. I still think it is of very great importance to secure a Museum of that character for Ireland. Colonel Adamson spoke of a deputation that came to me last year, and which I had the pleasure of receiving at the Castle on this subject. I may assure him I have not forgotten the matters then laid before me. They were of the greatest importance, but are not such as can be easily dealt with. There are several difficulties in the way of securing what we desire in this respect. I would point out that in Dublin there are a great number of Societies of a different kind, through which the Government give assistance to literature, art, and science; and that creates some difficulty in dealing with this subject. But if those present here to-night are studious readers of Parliamentary records, they will, during the last few days, have observed a very important Resolution carried by a distinguished member of the House of Commons, upon a motion for a Committee to be appointed on the Civil Service expenditure of the kingdom. I draw attention to that to show how very zealously the House of Commons watches any question of increased expenditure in this country. Among the different

subjects which probably will be inquired into by this Committee will be the Department of Science and Art, and I cannot but hope that, though they may find the expenditure increased somewhat in that department, they will arrive at the conclusion that the money has been well laid out; and if they do, I am sanguine we shall have some chance of carrying yet the proposition of having a central Museum for Industries and Arts in Dublin. This much I may assure you of, that none are more anxious to promote that end than the Government of this country, and that no exertion has been, or will be, spared either by my noble friend Lord Hartington or myself to obtain it. I will not detain you any longer, but will only again thank you for the very kind manner in which you have received the Resolution last proposed, and express a hope that those who have to-night received, perhaps, the first award of merit will continue to use their efforts in the study of the high arts—that they will be able to follow in the track of the many distinguished men and women who have belonged to this country, and who have thus distinguished Ireland.

The Viceregal party then withdrew, and the company shortly after separated.

SPRING CATTLE SHOW, 1878.

This annual National Exhibition was held on Tuesday, April 15th, and three following days.

Stock was entered as follows:—

Breeding Stock.	Bulls.		Heifers and Cows.	
Short Horns, Yearlings 148 / Other ages 57	205		28	
Herefords,	4		4	
Polled Angus,	8		4	
Devons,	3		3	
Kerrys,	6		14	
West Highlands,	2		2	
Ayrshire,	3		2	
Alderney,	9		7	
Other Stock,	1		2	
	241	+	66	307
Fat Stock,				51
Swine Lots,				33
Poultry, &c.,				385
				766
Implements, Machinery, &c., Lots,				2,000

The Chaloner Challenge Plate was won by Robert Hinson, Esq., Hill View, New-Ross for his Short-horned Bull, "St. Ruth," No. 187.

AFTERNOON SCIENTIFIC LECTURES.

The Series of those Lectures for the present year was devoted to subjects connected with public health. The Committee of Science who were entrusted with the duty of carrying out the arrangements were fortunate in having enlisted the co-operation of the Committee of the Dublin Sanitary Association, the result of their joint action being

that they secured the services of gentlemen distinguished not only for their professional eminence, but for their special acquaintance with the subjects upon which they kindly undertook to deliver the several discourses.

The following are the names of the Lecturers and the subjects upon which they lectured.

Saturday, February 22.—Introductory Discourse. William Stokes, Esq., M. D., D. C. L., F. R. S., Regius Professor of Physic, University of Dublin.

Saturday, March 1.—On the Discrimination of Unadulterated Food. J. Emerson Reynolds, Esq., M. R. C. P., Professor of Analytical Chemistry, and Keeper of the Minerals, Royal Dublin Society.

Saturday, March 8.—On Meteorolgy in its bearing on Health and Disease. John W. Moore, Esq., M. D., Physician to Cork-street Fever Hospital.

Saturday, March 15.—On the Geographical Distribution of Disease. James Little, Esq., M. D., Professor of the Practice of Medicine, Royal College of Surgeons, Ireland.

Saturday, March 22.—On Zymotic and Preventible Diseases. Thomas W. Grimshaw, Esq., M. D., Physician to Steevens' and the Fever Hospital, Cork-street.

Saturday, March 29.—On Liability to Disease. Alfred Hudson, Esq., M. D., President of the King and Queen's College of Physicians, Ireland.

Saturday, April 5.—On Antiseptics and Disinfection. Robert Macdonnell, Esq., M. D., F. R. S., Surgeon to Steevens' Hospital.

Saturday, April 12.—The Prevention of Artizans' Diseases. Edward Dillion Mapother, Esq., M. D., Medical Officer of Health to the City of Dublin, Professor of Anatomy and Physiology, Royal College of Surgeons, Ireland.

Saturday, April 19.—On the Contagion Theory of Epidemics. Rev. Samuel Haughton, M. D., F. T. C. D., F. R. S.

Saturday, April 26.—On the Construction of Dwelling Houses with Reference to their Sanitary arrangement. George Carlisle Henderson, Esq., Architect.

Saturday, May 3.—On Sanitary Legislation. Robert O'Brien Furlong, Esq., A. M., Barrister-at Law.

EVENING SCIENTIFIC MEETINGS AND DISCOURSES.

MONDAY, NOV. 18, 1872.

ROBERT STAWELL BALL, A. M., LL. D., in the Chair.

The CHAIRMAN opened the proceedings with some observations on the business of the Session. At the commencement of the business of the last Session he mentioned the desirability of investigations being made as to the value of peat as a fuel for industrial purposes. Since then the Committee of Science had inquired into and reported upon the suitability of peat for use in Siemen's gas furnace, the result being that it may be used as a fuel with advantage in such furnaces.

A Paper was then read in the absence of the Author by EDWARD HULL, ESQ., LL. D., F. R. S., " On the Present State of Coal Mining in the County of Tyrone," by E. T. HARDMAN, ESQ., F. R. G. S., Associate of the Royal College of Science of Ireland, and Assistant, Geological Survey of Ireland.

WM. BARKER, M. D., said that Mr. Hardman had not mentioned the percentage of ash in Dungannon Coal which, according to his experience, was very large, varying from 20 to 50 per cent.

MR. HULL said that the seams of Coal were of different purity. On the average the Coal was superior to Scotch, but inferior to the best English. There are two or three seams of very good Coal at Dungannon, which would pay well if properly worked.

Mr. Hull hoped that Mr Redwin, who had undertaken the investigation of the Coal-fields in Roscommon, &c., would make some observations.

MR. REDWIN said it was lamentable to hear Mr. Hardman's account of the way in which such good Coal as that of Dungannon was worked and wasted. These rich deposits ought to have been worked out long ago. He thought this Coal-field had been little worked till lately, and that drunkenness amongst the miners, and other difficulties, stood in the way of its being turned to proper account. He was astonished at the price charged at Dungannon for the very inferior Coal produced there. Near Lough, where the seams were only twenty inches thick, they had six seams open, and one hundred tons were raised last week. The cost of raising was low, and half the value of the Coal was given to the men at the pit's mouth. As the men were always paid by cheques, which their wives cashed, there was no drunkenness. The Coal-field was in a most prosperous condition, and they could find employment for many more men. If the railways would lower their rate to a halfpenny a ton per mile, their Coal would be delivered in Dublin at twenty or twenty-one shillings per ton.

The CHAIRMAN expressed his surprise at the manner in which the Dungannon Coal-field had been mismanaged. Mr. Hardman's Paper would be published immediately, and he hoped it would lead to better things.

DR. J. EMERSON REYNOLDS, Professor of Analytical Chemistry, read a Paper "On Superphosphates: their Adulterations and Valuation."

MR. W. F. KIRBY, Assistant in the Natural History Museum, communicated a translation of a Paper by H. D. J. Wallengren, of Färhult, Sweden, entitled "A Contribution to the Knowledge of the Lepidopterous Fauna of St. Bartholomew."

HOWARD GRUBB, Esq., C. E., then exhibited some portions of apparatus for the new Edinburgh Equatorial Telescope. He remarked that great annoyance was caused in observatories, which are generally very damp places, by the oxidation of the bright parts of aneroid instruments. To obviate this, the Americans had tried nickeling, which seemed to be very useful. The instrument had nearly the same appearance at night, it might be left in the water for a week without perceptible oxidation.

It was very difficult to obtain a good status for observations with a Newtonian Reflector. Mr. De la Rue had a movable stand, which could be screwed up and down, or wheeled from place to place. Mr. Grubb had invented a stand by which the observer could raise or lower himself, by merely holding the clamp open, without any sensible exertion.

MR. Grubb also exhibited a set of wheels by which a telescope could be altered from the sidereal rate of motion to the mean lunar rate; a very delicate motion was required for a spectroscope. The shaft of Mr. Grubb's instrument was formed by two cylinders let into one another. There was a governor arrangement which would prevent any acceleration of the clock, even if the weight of the pendulum was doubled.

The CHAIRMAN remarked on the usefulness of Mr. Grubb's inventions, and the popularity of his telescopes.

MR. KIRBY then called attention to some specimens belonging to the Natural History Museum, which were on the table, comprising a White Curlew, presented by Lord Ventry; a Brown variety of the Magpie, shot near Dublin; a shell of Bulimus Rosarens with its eggs, from Trinidad, presented by Captain Kelsall; two large South American Monkeys; a Great Bustard, from Turkey, &c.

MONDAY EVENING, DECEMBER 16, 1872.

On this occasion a Discourse was delivered on the Anthropoid Apes, by ALEXANDER MACALISTER, Esq., M. B., Professor of Zoology in the University of Dublin, and of Artistic Anatomy to the Society.

MONDAY EVENING, JANUARY 20, 1873.

ROBERT S. BALL, Esq , LL. D. in the Chair.

DAVID MOORE, Ph. D., Director of the Botanical Gardens of the Society, read a Paper on "The Successful Establishment of Loranthus Europæus (Mistletoe) on Oak

Trees in the Botanic Gardens; with Observations on the Cultivation of other Parisitical Plants therein."

PROFESSOR TANNER, M. R. A. C., read a valuable Paper "On the Comparative Trials of Fertilizers."

Dr. REYNOLDS spoke of the great importance of the Paper, and said that the Society were now engaged in carrying out Professor Tanner's suggestion as to experiments on Fertilizers. He did not agree with him as to the analysis of the soil not affording results of value to the practical farmer.

MONDAY EVENING, FEBRUARY 3, 1873.—SPECIAL MEETING.

JONATHAN PIM, ESQ., M. P., in the Chair.

WILLIAM ANDREWS read his Paper "On the State of the Sea Coast Fisheries of Ireland."

The CHAIRMAN remarked on the great interest of the subject, and hoped to hear the opinion of many gentlemen upon it. If the Irish Fisheries are to be developed, it should be by persons whose whole time is given to it, and not by men who are half fishermen and half farmers; but he did not see any harm in farmers who held land on the coast, and who generally have a boat for other purposes, looking after the shoals of herrings when they approached their coasts. They are very watchful, and are generally very successful. The railways will now always enable fish to find a market; whereas twenty or thirty years ago, frequently there was no market for them, and they were used as manure. He was anxious to know what was the present opinion on trawling. When a friend of his wanted to try trawling in Galway Bay, the people objected that it would destroy and drive away the fish. He wished to know if any trawling was done in Galway Bay at the present time, and what was thought of it.

THOMAS F. BRADY, Esq., Inspector of Fisheries, said that he had paid great attention to the subject of trawling, for more than twenty years. He was the first person to insist on the repeal of all restrictions on trawling in Galway Bay. He was strongly opposed to all such restrictions. The fishermen, however, were violently opposed to trawling; and last year two trawling boats were maliciously burnt, and several men were committed to trial for the outrage. The evidence given at the trial was, as usual, of the most contradictory character, and showed the danger of relying on sworn evidence in similar cases. What was needed to establish the truth was a series of carefully conducted experiments, carried out every month in the year, and on every available day and hour of the month; very useful results might then be hoped for. There was no truth in the allegations as to trawlers taking up spawn; but the real question to be proved was, whether trawlers really destroy such large quantities of small unmarketable fish, as to diminish the supply to any material extent? If it was proved, that at no time of the year does this great destruction take place, all bye-laws condemning trawling should be repealed at once. This was a question that should have been settled before by direct legislation; but he was happy to say that experiments such as he suggested were now being carried out, and he hoped, before the end of the year, to obtain sufficient evidence to enable him to give a decided opinion on the subject. The Society is greatly indebted to Mr. Andrews for bringing public opinion to bear on the subject. There was no question of greater importance to Ireland than that of the fisheries. Piers and harbours for fishing purposes were greatly required; and even those that existed were not built at proper places for fishermen. The sea fishing in Donegal Bay this year was one of the most productive within the memory of man. Nevertheless, many of the poorer fishermen were unable to avail themselves of the opportunity for want of capital. The principal hauls were obtained on the north coast of Donegal Bay; and the herring fishery was chiefly carried on by men from Donegal Bay and Ingle Bay. There were no other means of improving the fisheries than by loans, administered judiciously, and with great care. An annual grant for the promotion of the Irish Fisheries was greatly required; but till this was obtained the Commissioners were obliged to do as well as they could with the insufficient supplies at their command. Mr. Brady was under the impression, in 1867,

that a sum of money had been accumulating for forty years, which would be applicable; but on going into the matter, with one of the Crown lawyers, it was discovered that the money was barred by Act of Parliament. The fisheries ought to be developed by means of capital; and he could not understand why the Royal Irish Fisheries Company, which was doing very well in 1846 and 1847, should have failed; but all public fisheries companies had hitherto failed in Ireland. The South of Ireland Fisheries Company was managed by business men, and was going on very well at one time, and yet it collapsed, as several other companies had done, in spite of the very large capital with which they commenced. He could not understand how a Royal Charter could benefit a public Company, or how its loss hindered it from working, if it was really doing a good business. If the abeyance of the Charter prevented the raising of shares, that was no proof that the Company was in a good condition. He would ask for a Royal Charter for any Company if he thought it would be useful; but he was inclined to think that the fisheries should be developed in some better way.

Mr. Montgomery mentioned that one Fishing Company which started with a capital of £10,000 was wound up in a few years with no capital remaining. The South of Ireland Fisheries Company were paying £1000 a-year in salaries and other working expenses at the time of its collapse.

John A. Blake, Esq., Inspector of Fisheries, said that no subject admits of more difference of opinion than the present. Mr. Andrews had referred to a statement made by Mr. J. R. Barry, that some curing establishments paid 50 or 60 per cent. For his own part, he did not consider this a very large profit to make on such establishments. Mr. Andrews' Society had done a great deal of good in Ireland, and shows what may be done by careful management. A man receiving a loan from this Society must make 25 per cent. besides his support, to be able to pay it back again: so that an ordinary fisherman should make 50 per cent profit. According to Mr. Andrews, the ova of the cod sink to the bottom of the water; but Professor Sars thinks that no fish except herring and salmon is known to deposit its spawn at the bottom of the water. Sars found the ova of sea-fish floating at a distance from land; each ovum contains a small quantity of oil to enable it to float. Trawling can therefore do no harm, as the ova of fish floats free in the water. In 1857, Mr. Andrews, Professor Huxley, and Professor Allman and others were examined before a Parliamentary Commission. They had used the naturalist's dredge, an excellent instrument, and had never found any spawn at the sea bottom; but several of them stated that they had found ova floating on the surface of the water, which vivified when kept in a basin of sea-water. Even if ova were deposited at the sea bottom, it was in sheltered places where the trawl could not reach it. No atom of spawn was taken up in Galway Bay. He asked whether the men who combine farming and fishing are men that Government should be expected to subsidize? For his own part, he thought that the fisheries would never be carried on successfully except by men who combine the two pursuits. All Companies, &c., formed exclusively of fishermen had hitherto totally failed. He knew of twenty cases, or more. The South of Ireland Company had just wound-up by the sale of its effects for one-third of their value. The reason was, that no one was personally interested in saving every rope and spar, and in selling fish in the best market. When men were engaged who drew their income by salaries, Companies would always fail.

Mr. Goode was once connected with a Company which was only paying 8 per cent; but in one case he employed a Scotchman to whom he paid one-fourth of the profits, and found that this arrangement paid better than any other. Ireland was a very tempestuous country—he might say that it was the most tempestuous country in the world. If Companies were established, perhaps the crews could not get out at all for six weeks running, and then they become drunken and disorganized, and when fine weather comes they cannot be found when wanted; whereas private enterprise might realise 20 or 30 per cent. He fully approved of the system of combining farming and fishing. The farmer goes out to fish when the weather is favourable, but when he cannot, he goes to his farming, which keeps him out of the public house; but Companies' boats are too much shut up by bad weather to be profitable. Only the small farmers can fish successfully over the greater portion of the Irish coast. Where there were communities that

were exclusively fishermen, they became totally pauperised. This had been the case in Galway; and at Dungarvan, where there were formerly forty or fifty hookers, there were now only two or three. The little community of Ring, on the contrary, inhabited by half farmers and half fishermen, was now one of the most flourishing in Ireland. He thought that five times the amount that Mr. Andrews' Society could advance could be profitably employed. In many places its existence was hardly known; but it had already done much good, and could effect much more, if supplemented by Government loans. The country was greatly indebted to Mr. Andrews for his exertions in connexion with the Loan Society, the promotion of trawling, &c.

Mr. Andrews, in reply, said that no injury could be done by regular trawlers in Ireland, and he was very glad to hear from Mr. Brady that experiments were being carried on to prove that trawling did not destroy spawn. Sars says the ova of salmon have been detected floating down rivers, and lodge here and there on the banks. This is quite erroneous; and not one of the scientific men who said that they found cod or other ova floating out at sea, ever proved that they were ova. Herring rush into shallow water, and there deposit their ova. A friend of his had observed *mylotes arcticus*, a small species of the salmonidæ, spawning in this way on the coast of N. America. Indeed, so eagerly do they rush into shallow water to spawn, that if a wave washes over your boats, they are covered with spawn which the next wave carries off. The ova of fish is always deposited in situations where the trawl will not touch it. When a Royal Charter is granted to a Company, it protects everyone connected with it, in the exercise of powers of the greatest importance for its successful prosecution. The state of Ireland prevented shares being raised by the Royal Irish Fisheries Company, and the Charter therefore lapsed. The Company was not a failure, but had a balance of £3000 in hand. But its original promoters saw that nothing could be done without a renewal of the Charter, and withdrew from it; and it afterwards passed into other hands, in which it failed. But the only station where any returns of importance were made was at Killybegs. From this place a cargo of good fish was sent to Belfast and Dublin, which met with a good sale. No other stations sent up any; and the Killybeg fish were allowed to lie at Dublin so long, for want of proper instructions about their sale, that when Mr. Brown was sent for to inspect them, he directed them to be sold for manure. Very absurd views had been promulgated as to fish spawning in the open sea. The young fry are always to be met with in protected localities. The pools at low water are filled with the fry of the pilchard and the herring, which do not go into deep water until already of a good size. The Loan Society has to be conducted with the greatest discretion. Everything is done that can be done, but the principal is tied up, and only the interest available. Its existence is well known, as there are dozens of stations all round the coast. No one had mixed more among seamen than Mr. Andrews, and, according to his experience, the men who combined farming with fishing were men who would never supply means for resources, and it was generally found that they spent the money on their holdings. Great good would be effected by vesting the necessary powers in Commissioners. The men should be tutored to understand their business, and to give proper returns to the Commissioners; before all things it was requisite that they should be properly educated and trained for this object.

The Chairman remarked on the great exertions of Mr. Andrews in promoting the fisheries for so many years. In spite of differences of opinion, he was glad to see that all agreed that the spawn was not likely to be injured by trawling, which was really the practical question. He saw no objection to a man making something by casual fishing, though he thought that the fishing industry would be best developed by those whose whole time was given to it. If a gentleman would make the promotion of a Company his own private interest, he had no doubt that it would succeed. Where a Company would make 10 per cent., a single person ought to make 20 per cent. He thought that with proper care more money could be advantageously dispensed in the encouragement of the fisheries than at present.

MONDAY EVENING, FEBRUARY 17, 1878.

EDWARD HULL, ESQ., F. R. S., Director of the Geological Survey of Ireland, in the Chair.

R. W. M'NAB, ESQ., M. D., *Professor of Botany, Royal College of Science, Ireland,* delivered a discourse, "On Calamites,—fossil plants of the Coal-period—and their relation to the Equiseta of the present day."

MONDAY EVENING, MAY 19, 1878.

HOWARD GRUBB, Esq., C. E., in the Chair.

DAVID GILL, ESQ., F. R. A. S., Director of the Observatory, Dunecht, Aberdeenshire, delivered a discourse, "On the Irregularity of Public Clocks, and its remedy."

GEO. JOHNSTONE STONEY, A. M., F. R. S., one of the Secretaries of the Society, said that Mr. Gill was entitled to the thanks of the meeting for the important discourse he had just delivered. The Society had requested the Committee of Science to report on the subject of the want of accurate time in the city of Dublin, but they had experienced some difficulty in obtaining information on some important details. Mr. Gill had rendered most important information and assistance; and advantage was taken of his stay in Dublin to request him to give a lecture on the subject, with which he had not only heartily complied, but, at considerable expense and trouble, had procured the apparatus he used in illustration of his discourse.

THE CHAIRMAN said he hoped the time was not far distant when the Clocks of Dublin would be regulated in the manner described by Mr. Gill. It was necessary to state that the Transit Circle at Dunsink was only in course of erection.

MR. GILL thanked Mr. Yeates for the assistance Mr. Yeates had afforded him in procuring the necessary apparatus.

MONDAY EVENING, JUNE 16, 1878.—*Supplemental Meeting.*

WM. NEILSON HANCOCK, LL. D., in the Chair.

J. G. V. PORTER, ESQ., read a paper "On the Drainage of Lough Erne, and its connexion with its Local Navigation and the Canals, from Belfast and Newry, through thirteen counties to Limerick." Also, on the best practical means of bringing the whole northern Irish Canal system and immense motive power of the Shannon and Lough Erne into active usefulness.

RESULTS AS TO MEAN TEMPERATURE, DIRECTION OF THE WIND, AND RAINFALL,

DEDUCED

From the Glasnevin Observations from 1847, *to Sept.* 1872.

By Hugh Breen.

TABLE I.

MEAN MONTHLY TEMPERATURES.

Deduced from the Readings of the Self-registering Maximum and Minimum Thermometers at the Botanical Gardens, Glasnevin, from July, 1847, *to December,* 1849, *inclusive; and from January,* 1852, *to September,* 1872, *also inclusive.*

The formula used for each monthly result is—

$$\text{Minimum} + (\text{Max.} - \text{Min.}) \times \text{factor } (a)$$

This factor has been deduced from a comparison of the Two-Hourly Observations of the Thermometer, 1841, 1842, 1843 (Observatory of Trinity College, Dublin) with the results of a Self-registering Thermometer in the same period. It differs materially from a similar table given by Kæmtz in his Meteorology.

Factor (a)

January, February, March, April, December	$a = 0·407$	May, June, July, August, September	$a = 0·478$
		October, November	$a = 0·357$

MEAN MONTHLY TEMPERATURE, 1847 TO 1872.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.
1847	..	..	..	..	..	..	63·4	59·5	53·7	49·6	46·3	41·5
1848	..	..	..	..	..	..	59·9	56·3	55·9	48·3	41·5	42·1
1849	40·8	43·4	43·6	42·8	52·9	55·9	59·6	59·7	56·3	48·3	44·8	39·1
1852	42·5	41·9	41·9	45·9	53·0	55·7	62·8	62·7	54·6	46·0	44·6	44·7
1853	40·1	38·8	39·4	45·6	50·4	57·9	59·1	57·7	54·1	48·3	42·4	36·4
1854	39·7	41·1	45·0	48·1	50·0	55·0	58·8	60·0	57·0	48·4	42·0	40·9
1855	39·2	31·5	38·9	44·3	49·7	54·5	63·1	63·2	57·5	48·7	43·4	39·5
1856	39·8	42·5	40·3	44·5	49·2	57·4	59·5	61·9	52·9	48·3	41·5	40·4
1857	36·6	41·1	41·3	43·5	52·1	58·2	60·5	62·8	58·0	50·4	46·1	47·1
1858	41·1	38·9	40·6	45·6	51·5	59·8	57·4	65·5	57·9	47·0	48·3	47·3
1859	40·7	41·7	44·4	44·5	51·1	60·1	59·7	57·4	53·4	47·4	40·3	35·3
1860	37·0	36·5	40·1	42·2	50·5	53·9	56·3	55·1	49·3	43·9	40·4	35·1
1861	40·4	40·8	40·8	44·1	55·8	60·1	54·6	60·0	54·1	44·2	39·7	43·1
1862	40·7	41·5	41·8	43·6	49·1	55·8	55·6	55·9	54·2	47·5	36·7	42·5
1863	39·8	42·1	43·8	45·0	50·7	55·4	57·0	57·8	51·1	49·6	47·3	41·1
1864	38·0	35·9	40·3	47·1	53·0	54·6	59·0	55·6	54·3	47·5	40·8	38·7
1865	35·5	38·9	38·8	47·1	52·3	60·2	60·1	57·1	60·2	48·0	40·9	40·6
1866	40·4	38·3	39·5	46·0	48·7	57·8	60·5	57·8	52·8	48·2	42·2	44·0
1867	34·5	44·0	38·7	48·0	..	...	..	..	55·8	48·2	41·7	40·5
1868	40·1	43·4	45·3	44·6	56.4	63·7	62·9	58·5	56·0	45·6	42·3	44.0
1869	42·6	45·2	38·8	47·8	46·9	54·6	61·2	57·9	56·1	50·1	42·2	36·8
1870	38·7	38·0	41·1	46·4	54·6	58·1	61·5	59·0	56·5	44·9	39·9	34·1
1871	35·2	43·8	43·4	46·3	56·9	54·7	57·3	59·3	54·0	48·2	40·0	39·1
1872	39·3	43·3	42·7	44·9	48·0	54·2	59·5	60·9	53·5	..	..	..
Mean for each Month	39·2	40·3	41·4	45·8	51·1	57·0	59·5	59·2	55·6	47·7	42·2	40·6

MONTHLY MEAN TEMPERATURES.

January	.. 39°·2	August	.. 59°·2
February	.. 40·3	September	.. 55·6
March	.. 41·4	October	.. 47·7
April	.. 45·8	November	.. 42·2
May	.. 51·1	December	.. 40·6
June	.. 57·0		
July	.. 59·5	Mean of Year	.. 48·2

TABLE II.

YEARLY MEAN TEMPERATURES.

1849 ..	.. 48°·9	1862 ..	.. 47°·0
1852 ..	.. 49·7	1863 ..	.. 48·4
1853 ..	.. 47·1	1864 ..	.. 47·1
1854 ..	.. 48·9	1865 ..	.. 48·3
1855 ..	.. 47·8	1866 ..	.. 48·0
1856 ..	.. 48·2	1867 (imperfect.)	
1857 ..	.. 49·8	1868 ..	.. 50·2
1858 ..	.. 49·7	1869 ..	.. 48·3
1859 ..	.. 48·0	1870 ..	.. 47·5
1860 ..	.. 45·0	1871 ..	.. 47·7
1861 ..	.. 48·1		

TABLE III.

MEAN MONTHLY RANGE OF TEMPERATURE,

From the Readings of the Maximum and Minimum Self-registering Thermometers.

	°			°	
January	8·7	22 years' Observations.	July	15·8	23 years' Observation
February	10·8	,, ,, ,,	August	15·9	,, ,, ,,
March	12·2	,, ,, ,,	September	14·5	24 years' ,,
April	15·8	,, ,, ,,	October	12·2	23 years' ,,
May	16·6	21 years' ,,	November	10·2	,, ,, ,,
June	16·2	,, ,, ,,	December	9·0	,, ,, ,,

Summer.	Winter.	Year.
15°·7	10°·4	13°·1

TABLE IV.

MEAN DIRECTION OF THE WIND AT THE BOTANICAL GARDENS, GLASNEVIN.

1852 *to September*, 1871.

	E.	N.E.	N.	N.W.	W.	S.W.	S.	S.E.
January ..	2	2	0	4	5	11	2	5
February ..	1	2	1	4	5	9	1	5
March ..	3	6	1	5	4	6	1	5
April ..	2	6	1	4	2	7	1	7
May ..	4	6	0	5	3	7	1	5
June ..	2	3	0	5	4	8	1	7
July ..	3	4	0	5	4	8	1	6
August ..	2	3	0	6	5	7	1	7
September ..	2	3	1	4	5	9	1	5
October ..	2	4	1	6	5	7	1	5
November ..	1	3	1	6	5	7	1	6
December ..	1	2	1	5	5	10	2	5

RESULTANT DIRECTION.

January	S. 47° W.	July	S. 38° W.
February	S. 50 W.	August	S. 42 W.
March	S. 65 W.	September	S. 47 W.
April	S. 23 E.	October	S. 67 W.
May	S. 29 E.	November	S. 74 W.
June	S. 44 W.	December	S. 56 W.

For year .. S. 40° W.

TABLE V.

RAIN COLLECTED AT THE BOTANIC GARDENS, GLASNEVIN, JULY, 1847, TO SEPTEMBER, 1872.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1847 ..	..	...	..	...	..	..	0·635	1·633	1·539	1·097	2·224	2·882
1848 ..	..	..	..	.	..	..	2·245	5·145	2·620	4·877	1·492	2·527
1849 ..	8·580	0·859	1·313	2·715	1·967	0·507	2·750	4·302	8·471	3·889	1·623	4·234
1852 ..	2·640	2·730	0·450	0·890	2·200	6·840	1·840	4·170	8·740	8·810	6·710	8·540
1853 ..	2·580	1·370	1·620	1·910	0·850	2.350	1·990	1·940	2·760	3·960	1·700	0·600
1854 ..	8·020	1·810	0·310	0·290	1·840	3·875	1·700	1·220	1·040	1·450	2·700	1·660
1855 ..	1·010	2·240	1·180	0·590	1·820	2·060	3·600	8·070	1·880	8·640	1·490	1·400
1856 ..	1·970	0·790	0·860	1·580	5·450	2·180	1·080	2·470	3·810	1·630	0·600	2·580
1857 ..	2·570	0·900	2·800	3·550	1·290	2·860	1·110	1·590	2·030	2·150	2·140	0.860
1858 ..	0·830	0·720	0·970	4·420	1·456	1·240	2·910	1·300	2·510	8·380	0·610	2·480
1859 ..	1·600	0·650	2·580	4·120	0·150	1·260	1·260	2·020	3·170	1·250	2·030	2·770
1860 ..	3·560	0·690	1·950	2·280	3·670	3·380	2·670	4·180	1·990	1·870	2·310	2·600
1861 ..	2·150	2·990	3·050	1·500	0·180	2·990	4·940	2·850	3·620	2·060	2·920	0·920
1862 ..	3·030	0·570	2·990	3·810	2·420	2·240	3·880	1·840	2·140	2·710	1·440	1·870
1863 ..	2·490	0·400	1·560	1·300	1·186	2·120	0·680	2·920	2·770	6·010	2·510	2·160
1864 ..	1·450	1·030	2·580	0·780	1·590	1·140	0·870	0·920	1·590	6·130	3·850	2·070
1865 ..	1·490	1·830	1·150	1·100	3·120	0·750	2·030	3·950	0·030	3·350	2·710	2·870
1866 ..	1·490	1·330	3·480	1·210	0·640	3·500	1·200	1·980	3·350	1·420	1·820	1·510
1867 ..	2·930	1·380	3·720	2·800	..	..	..	..	1·590	2·625	0·570	1·410
1868 ..	2·340	1·510	1·680	1·720	1·090	0·720	0·640	4·470	2·290	0·770	1·700	4·670
1869 ..	4·220	1·800	2·290	1·800	5·100	0·600	0·700	1·090	2·550	2·240	2·180	2·250
1870 ..	1·850	0·780	1·920	1·170	1·100	0·750	0·980	1·490	1·560	2·170	0·760	1·820
1871 ..	3·050	1·260	0·690	2·660	0·260	1·870	4·950	1·310	3·790	2·620	1·180	1·060
1872 ..	2·590	2·860	3·160	2·900	7·460	3·650	3·650	4·700	2·880	3·470	3·120	4·880

TABLE VI.

MEAN MONTHLY AMOUNT OF RAIN AT BOTANIC GARDENS, GLASNEVIN.

	Inches.	
January	2·384	from 22 years' Observations.
February	1·341	" " "
March	1·918	" " "
April	2·022	" " "
May	1·928	" 21 years' "
June	2·232	" " "
July	2·074	" 23 years' "
August	2·684	" " "
September	2·424	" 24 years' "
October	2·874	" 23 years' "
November	2·031	" " "
December	2·179	" " "
	26·041	Annual Mean amount of above.

TABLE VII.

ANNUAL AMOUNT OF RAIN COLLECTED AT THE BOTANICAL GARDENS, GLASNEVIN.

	Inches.		Inches.
1849	31·210	1862	27·940
1852	39·580	1863	26·050
1853	23·630	1864	23·950
1854	20·950	1865	24·360
1855	28·930	1866	22·880
1856	24·450	1868	28·550
1857	23·350	1869	26·270
1858	22·770	1870	16·300
1859	22·860	1871	24·700
1860	31·100		
1861	30·120	Mean of the above 20 years	25·472

TABLE,

SHOWING THE RAINFALL IN 1873,

At Glasnevin Botanic Gardens, in the County of Dublin.

Rain Gauge, { Diameter of Funnel, 36 inches. Height of top { Above Ground, 9½ feet. Above Sea Level, 69½ feet.

Month.		Total Depth.	Greatest Fall in 24 hours.		No. of Days on which ·01 or more fell.
		Inches.	Depth.	Date.	
January,	..	3·130	·960	16th	21
February,	..	·380	·140	25th	6
March,	..	2·170	·500	7th	17
April,	..	·620	·150	18th	10
May,	..	1·100	·250	11th	12
June,	..	1·150	·300	12th	8
July,	..	3·140	·440	28th	20
August,	..	4·260	·700	24th	16
September,	..	2·320	1·840	14th	11
October,	..	3·370	·840	25th	18
November,	..	2·320	·550	6th	14
December,	..	·670	·380	19th	7
Total,	..	24·680	—	—	160

NOTE.—In the above Table, the Rainfall read at noon on any given day is entered to the credit of *that* day. In the Table on page 469, the Rainfall read at 9 A.M. on any given day is entered to the credit of the *preceding* day.

TABLE,

SHOWING THE RAINFALL IN 1873,

At 40, *Fitzwilliam-square, West, in the County of the City of Dublin.*

Rain, Gauge, { Diameter of Funnel, 5 inches.
Height of top { Above Ground, 3 feet 4 inches.
Above Sea Level, 54 feet.

Month.	Total Depth.	Greatest Fall in 24 hours.		No. of Days on which ·01 or more fell.
	Inches.	Depth.	Date.	
January, ..	2·650	1·089	15th	21
February, ..	·925	·429	24th	8
March, .	2·891	·542	6th	22
April, ..	·498	·285	17th	8
May, ..	·907	·115	10th	17
June, ..	·939	·280	15th	13
July, ..	3·408	·740	22nd	25
August, ..	3·944	·928	24th	23
September, ..	2·368	1·181	13th	13
October, ..	3·089	1·171	24th	18
November, ..	2·009	·506	13th	14
December, ..	·692	·295	18th	7
Total, ..	23·820	—	—	189

An inch of rain, or upwards, fell in the 24 hours, from 9 A.M. to 9 A.M. on January 15th (1·089 inches), September 13th (1·181 inches), and October 24th (1·171 inches.)

Mean Rainfall of *Eight* years (1865–72) = 26·871 inches.

Mean Number of Rainy Days in *Eight* years (1865–72) = 186.

Mean Rainfall of *Nine* years (1865–73) = 26·532, inclusive.

Mean Number of Rainy Days in *Nine* years (1865–73) = 186·5.

TABLE,

SHOWING THE RAINY DAYS* AT DUBLIN, 1865, TO 1872, INCLUSIVE.

From Observations made by J. W. Moore, M. D., F. K. Q. C. P. Irel., Ex-Scholar of Trinity College, Dublin.

MONTH.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	MEANS.
January	13	22	17	17	18	14	20	23	18·00
February	20	22	18	14	18	18	16	20	18·25
March	14	21	22	11	17	11	12	21	16·13
April	9	18	25	12	14	8	20	12	14·75
May	19	13	12	10	19†	14	9	22	14·75
June	5	17	6	6	11	9	16	19	11·12
July	17	13	17	5	9	8	28‡	12	13·63
August	19	20	16	13	10	7	12	17	14·25
September	8§	22	13	11	21	11	13	22	14·50
October	17	13	20	15	11	18	16	22	17·75
November	18	15	8	19	17	11	14	24	15·75
December	15	19	13	27	20	16	15	24	18·62
TOTAL	169	215	187	160	185	145	191	238	186
Rainfall of year in inches.	" 27·562	" 25·879	" 27·241	" 24·935	" 27·559	" 20·859	" 25·368	" 35·566	" 26·871

		Inches.
Mean Rainfall of the *Seven* years (1865–71, inclusive)		= 25·629
,, ,, ,, *Eight* years (186-572, inclusive)		= 26·871
Mean Number of Rainy Days in the *Seven* years	..	= 179
,, ,, ,, ,, *Eight* years	..	= 186

	Per Cent.
Excess of Rainfall of 1872 over Mean of *Seven* years	= 38·77
,, ,, ,, ,, *Eight* years	= 24·92
,, Rainy Days of 1872 over Mean of *Seven* years	= 32·96
,, ,, ,, ,, ,, *Eight* years	= 27·96

* Days on which ·01 inch, or upwards, of rain fell within the 24 hours.
† Month of the heaviest Rainfall = 5·414 inches.
‡ Wettest month of the *Eight* years, Rainfall = 4·391 inches.
§ Driest ,, ,, ,, ,, ,, = ·056 of an inch.

APPENDIX.

METEOROLOGICAL JOURNAL,

KEPT AT

The Royal Dublin Society's Botanic Garden, Glasnebin,

[HEIGHT ABOVE LEVEL OF SEA, 65 FEET,]

FROM

1st OCTOBER, 1872, to 31st DECEMBER, 1873.

OCTOBER, 1872.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Tuesday, . .	29·500	59	29·423	60	54	51	52	53	62	59	S. W.	2	·060	Breezy, showery, occasional sunshine.
2 Wednesday, .	29·200	60	29·118	61	50	48	52	54	62	59	S. W.	5	·000	Fine, breezy, bright sunshine.
3 Thursday, . .	29·492	52	29·430	53	45	43	50	53	54	52	N. W.	5	..	Do.
4 Friday, . . .	29·950	48	29·898	49	40	38	47	50	50	48	S. W.	3	·150	Cloudy, showery, occasional sun.
5 Saturday, . .	30·250	59	30·198	50	31	30	44	47	51	49	N. E.	2	·000	Cloudy, occasional sun, light frost.
6 Sunday, . .	30·200	55	30·152	59	30	29	45	47	60	58	S. W.	5	.	Fine, bright sun, light frost.
7 Monday, . .	29·994	55	29·927	55	52	50	48	49	56	54	S. W.	0	·150	Cloudy, wet, changeable day.
8 Tuesday, . .	29·940	52	29·896	54	39	38	47	49	56	54	N. W.	3	·040	Breezy, showery, occasional sunshine.
9 Wednesday, .	29·650	52	29·588	50	46	44	47	49	50	48	N. W.	2	·360	Breezy, heavy showers, occasional sun.
10 Thursday, . .	29·100	48	29·049	54	39	37	46	48	56	53	S. W.	1	·150	Do.
11 Friday, . .	29·550	47	29·504	48	36	34	44	46	49	47	N. W.	3	·190	Do.
12 Saturday, . .	29·750	48	29·698	50	35	33	46	49	51	49	N. W.	3	·000	Breezy, cloudy, occasional sunshine.
13 Sunday, . . .	29·800	47	29·754	50	37	35	43	46	51	49	S. W.	3	·090	Breezy, showery, occasional sunshine.
14 Monday, . .	30·022	45	29·980	50	31	29	42	45	52	50	N. W.	4	·000	Fine, bright sun, light frost.
15 Tuesday, . .	29·700	47	29·654	49	35	33	42	44	49	47	S. E.	0	·100	Cloudy, showery, changeable.
16 Wednesday, .	29·484	45	29·444	47	36	35	42	44	48	46	N. W.	2	·290	Breezy, heavy showers, occasional sun.
17 Thursday, . .	29.700	52	29·638	53	43	41	43	45	54	51	N. E.	2	·450	Breezy, heavy rain, occasional sun.
18 Friday, . . .	29·684	50	29·627	52	42	40	44	45	51	49	N. E.	0	·040	Breezy, cloudy, light showers.
19 Saturday, . .	29·450	50	29·394	52	45	43	45	46	53	50	S. E.	0	·430	Breezy, wet, changeable.
20 Sunday, . . .	29·698	47	29·652	48	39	37	44	46	49	47	N. W.	0	·070	Cloudy, showery, changeable.
21 Monday, . .	29·600	45	29·559	47	42	40	44	46	48	46	N. W.	0	·060	Do.
22 Tuesday, . .	29·526	45	29·485	48	34	33	42	45	50	48	N. W.	3	·000	Fine, breezy, bright sunshine.
23 Wednesday, .	29·680	45	29·639	48	36	34	42	44	50	48	S. W.	2	..	Breezy, cloudy, occasional sunshine.
24 Thursday, . .	29·000	50	28·944	51	43	41	43	45	52	50	S. E.	1	·240	Heavy showers, occasional sunshine.
25 Friday, . . .	28·950	51	28·895	51	42	40	43	45	51	49	S. E.	0	·100	Stormy, showery, changeable.
26 Saturday, . .	29·136	52	29·075	52	42	40	45	46	54	52	S. E.	0	·260	Cloudy, heavy showers, chang eable
27 Sunday, . . .	29·550	50	29·493	53	36	34	44	46	53	51	N. E.	2	·000	Cloudy, mild, changeable.
28 Monday, . .	29·800	47	29·754	50	41	39	44	46	51	49	S. W.	1	..	Do.
29 Tuesday, . .	29·740	53	29·678	55	45	43	46	47	56	53	S. W.	0	·040	Breezy, light showers.
30 Wednesday, .	29·480	50	29·424	51	47	46	46	48	51	49	S. W.	1	·200	Breezy, showery, occasional sun.
31 Thursday, .	29·500	50	29·443	52	42	41	45	47	53	50	S. W.	3	·000	Fine, breezy, bright sunshine.
												58	3·470	inches.

NOVEMBER, 1872.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	Therm.	Corrected for Temperature only.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
1 Friday, . . .	29·160	50°	29·104	51°	42°	40°	44°	46°	52°	50°	S. W.	0	·000	Breezy, showery, changeable.
2 Saturday, . . .	29·050	44	29·010	44	40	39	41	44	45	44	S. W.	0	·110	Do.
3 Sunday, . . .	29·840	45	29·794	46	43	41	42	44	47	45	S. W.	2	·190	Breezy, showery, occasional sunshine.
4 Monday, . . .	29·628	52	29·566	54	34	32	43	44	54	52	S. W.	0	·140	Breezy, light showers, changeable.
5 Tuesday, . . .	29·700	52	29·638	52	52	50	47	48	53	51	S. W.	2	·060	Do.
6 Wednesday, . .	29·440	62	29·353	63	51	50	59	50	63	60	S. W.	3	·000	Very stormy, occasional sunshine.
7 Thursday, . . .	30·100	52	30·037	53	45	44	46	48	54	52	S. W.	2	·040	Breezy, light showers, occasional sun.
8 Friday, ...	30·190	50	30·132	51	45	43	46	48	52	50	S. W.	2	·060	Do.
9 Saturday, . . .	30·000	47	29·953	48	42	40	44	46	49	47	S. W.	2	·030	Do.
10 Sunday, . . .	30·050	48	30·014	44	35	34	42	44	46	44	S. W.	2	·050	Breezy, light showers, occasional sunshine.
11 Monday, . . .	30·160	39	30·134	42	32	31	39	42	44	43	N. W.	3	·000	Fine, breezy, bright sunshine.
12 Tuesday, . . .	30·200	41	30·169	44	35	33	39	41	46	44	N. E.	3	· ·	Do.
13 Wednesday, . .	30·230	38	30·204	43	32	32	39	41	42	40	N. E.	2	·120	Breezy, occasional sun, hail-showers.
14 Thursday, . . .	30·040	36	30·014	38	35	33	38	40	40	39	N. E.	0	·000	Breezy, cloudy, changeable day.
15 Friday, ...	30·200	41	30·169	42	37	35	38	40	42	40	N. E.	1	·110	Cloudy, showers of hail, occasional sun.
16 Saturday, . . .	29·688	38	29·663	39	36	34	37	40	39	38	N. W.	0	·080	Breezy, cloudy, showery day.
17 Sunday, . . .	29·794	36	29·774	39	32	30	36	38	40	39	N. W.	2	·150	Breezy, showery, occasional sunshine.
18 Monday, . . .	29·240	42	29·205	45	33	31	37	39	45	43	N. W.	0	·410	Breezy, heavy rain, changeable.
19 Tuesday, . . .	29·134	41	29·104	43	31	30	37	39	44	42	S. E.	0	·060	Breezy, showery, changeable.
20 Wednesday, . .	29·134	47	29·089	50	40	39	39	40	52	50	S. W.	3	·040	Breezy, light showers, bright sun.
21 Thursday, . .	29·350	44	29·310	46	40	39	38	41	47	45	S. E.	0	·000	Cloudy, mild, changeable.
22 Friday, ...	29·250	46	29·205	48	39	37	40	41	49	47	S. W.	3	·510	Breezy, heavy rain, bright sun.
23 Saturday, . . .	28·568	51	28·503	54	40	38	41	43	54	52	S. W.	2	·500	Stormy, heavy rain, occasional sun.
24 Sunday, . . .	29·064	48	29·013	49	40	38	41	43	50	48	S. W.	2	·060	Breezy, showery, occasional sunshine.
25 Monday, . . .	29·800	44	29·760	46	30	29	39	41	47	45	S. E.	0	·100	Breezy, showery, changeable day.
26 Tuesday, . . .	29·050	50	28·994	51	46	44	42	43	51	49	S. W.	1	·090	Do.
27 Wednesday, . .	29·550	47	29·504	49	45	43	42	48	50	48	S. W.	1	·000	Cloudy, mild, changeable.
28 Thursday, . .	29·640	39	29·615	40	36	35	40	42	41	40	S. W.	0	· ·	Foggy, cloudy, cold. changeable.
29 Friday, . . .	29·200	40	29·170	43	33	32	39	41	44	42	S. E.	0	·060	Breezy, showery, changeable.
30 Saturday, . .	28·650	45	28·520	47	40	39	40	41	47	45	S. E.	0	·150	Do.
												38	3·120	Inches.

DECEMBER, 1872.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Sunday, . .	28·750	45	28 710	47	42	40	41	42	47	45	S. E.	1	·300	Breezy, wet, occasional sunshine.
2 Monday, . .	29·550	46	29·504	47	43	41	41	43	48	46	N. E.	0	·340	Do.
3 Tuesday, . .	29·636	38	29·605	40	36	34	40	42	42	40	N. W.	2	·000	Fine, breezy, bright sunshine.
4 Wednesday, .	29·928	35	29·913	37	32	31	38	40	39	38	N. W.	2	· ·	Do.
5 Thursday, . .	29·450	42	29·415	45	29	28	38	40	47	45	S. E.	0	·140	Cloudy, wet, changeable.
6 Friday, . . .	29·250	44	29·210	46	42	40	39	41	47	45	S. W.	2	·100	Breezy, showery, bright sunshine.
7 Saturday, .	29·300	41	29·270	43	37	35	38	40	44	43	S. W.	2	·000	Fine, breezy, bright sunshine.
8 Sunday, . .	29·040	39	29·017	41	37	36	37	39	41	40	S. E.	0	·070	Breezy, cloudy, showery, changeable.
9 Monday, . .	28·950	37	28·941	37	33	32	35	37	41	40	N. W.	3	·620	Breezy, heavy rain, bright sunshine.
10 Tuesday, . .	28·980	35	28·966	39	32	30	36	38	37	36	W.	0	·050	Cloudy, cold, light showers.
11 Wednesday, .	29·550	34	29·535	36	31	29	34	36	37	36	S. W.	2	·249	Cloudy, showery, occasional sunshine.
12 Thursday, . .	29·900	31	29·896	31	30	28	33	36	33	32	N. W.	2	000	Cloudy, hail-showers, occasional sun.
13 Friday, . . .	29 600	39	29·575	42	27	26	34	36	41	40	N. W.	0	·070	Breezy, showery, changeable.
14 Saturday, . .	29·450	42	29·415	42	32	30	35	37	43	42	N. E.	0	·000	Breezy, cloudy, cold, changeable.
15 Sunday, . . .	29·710	40	29·680	42	41	40	37	39	42	41	N. W.	0	·110	Cloudy, showery, changeable.
16 Monday, . .	29 600	40	29·570	42	37	36	37	38	42	41	S. E.	0	·060	Do.
17 Tuesday, . .	29·450	37	29·430	39	38	36	36	38	38	38	S. W.	0	·300	Breezy, heavy rain, changeable.
18 Wednesday, .	29·650	30	29·646	30	29	28	34	36	32	32	N. W.	1	·000	Cloudy, occasional sunshine.
19 Thursday, . .	29·500	38	29·475	41	32	31	36	38	43	42	S. W.	2	·890	Occasional sun, heavy showers.
20 Friday, . . .	29·300	41	29·270	41	39	36	37	39	42	41	S. E.	0	·200	Breezy, heavy showers, cold.
21 Saturday, . .	29·382	46	29 337	47	41	39	39	40	47	46	S. E.	0	·360	Cloudy, mild, wet, changeable.
22 Sunday, . . .	29·590	52	29·528	53	45	44	41	42	54	52	S. W.	0	·220	Cloudy, showery, changeable.
23 Monday, . .	29·260	51	29·204	52	49	48	43	44	53	51	S. W.	2	·060	Breezy, showery, occasional sun.
24 Tuesday, . .	28·866	49	28·816	49	46	44	42	44	50	48	S. W.	0	·180	Breezy, showery, changeable.
25 Wednesday, .	28·730	48	28·668	49	44	43	42	44	50	48	S. W.	2	·090	Fine, mild, occasional sunshine.
26 Thursday, . .	29·400	47	29·355	50	35	34	41	43	51	49	S. W.	2	·110	Breezy, showery, occasional sun.
27 Friday, . . .	29·300	52	29·239	52	47	46	43	45	53	51	S. W.	0	·160	Breezy, cloudy, showery, changeable.
28 Saturday, . .	29·500	44	29 459	46	43	42	43	45	47	46	S. W.	0	·060	Do.
29 Sunday, . .	29·820	38	29·768	41	34	32	40	43	43	42	N. W.	3	·000	Fine, breezy, bright sunshine.
30 Monday, . .	29·700	38	29·648	42	26	25	36	38	44	42	S. E.	1	· ·	Breezy, cloudy, changeable.
31 Tuesday, . .	29·200	44	29·160	44	42	40	39	41	45	43	S. E.	1	·100	Cloudy, showery, occasional sun.
												30	4·830	inches.

JANUARY, 1873.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature on ly.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Wednesday, . .	29·540	42	29·504	45	39	37	38	40	47	45	S. W.	8	·000	Fine, breezy, bright sunshine.
2 Thursday, . . .	29·226	41	29·196	43	39	37	38	40	44	43	S. W.	2	·090	Breezy, showery, occasional sun.
3 Friday, . . .	29·226	44	29·186	46	38	36	39	41	46	45	S. W.	2	·060	Do.
4 Saturday, . .	29·292	44	29·252	46	37	35	38	40	47	46	S. E.	1	·050	Do.
5 Sunday, . . .	29·538	38	29·513	40	37	35	37	39	41	40	S. W.	2	·080	Breezy, showery, occasional sunshine.
6 Monday, . . .	29·600	42	29·564	46	38	36	38	40	48	46	S. W.	1	·060	Do.
7 Tuesday, . . .	29·732	48	29·680	50	39	48	42	43	52	50	S. W.	3	·000	Fine, breezy, bright sunshine.
8 Wednesday, . .	29·400	45	29·360	48	47	45	42	43	46	44	S. W.	0	·030	Stormy, light showers, changeable.
9 Thursday, . . .	29·250	47	29·205	49	40	39	41	43	50	48	S. W.	0	·020	Cloudy, light showers, changeable.
10 Friday, ...	29·400	50	29·344	50	46	45	42	43	51	49	S. W.	0	·040	Do.
11 Saturday, . . .	29·592	51	29·540	52	47	44	42	43	53	51	S. W.	8	·060	Breezy, showery, bright sunshine.
12 Sunday, . . .	29·800	46	29·764	46	35	34	40	42	47	46	S. W.	8	·060	Breezy, showery, occasional sunshine.
13 Monday, . . .	29·750	53	29·688	53	44	43	43	44	54	52	S. W.	0	·190	Breezy, cloudy, showery.
14 Tuesday, . . .	29·840	52	29·783	52	49	47	45	45	53	51	S. W.	1	·000	Fine, breezy, occasional sunshine.
15 Wednesday, . .	29·840	44	29·799	44	43	42	43'	44	45	44	W.	0	·180	Cloudy, showery, changeable.
16 Thursday, . . .	29·700	48	29·654	48	40	39	42	43	49	47	S. E.	0	·960	Breezy, cloudy, heavy rain, changeable.
17 Friday, . . .	29·740	43	29·704	45	35	33	39	42	46	45	S. W.	0	·020	Breezy, light showers, changeable.
18 Saturday, . . .	29·150	44	29·110	45	35	33	39	42	46	45	S. W.	0	·040	Do.
19 Sunday, . . .	28·540	36	28·521	37	36	34	38	40	38	37	S. E.	1	·200	Breezy, heavy showers, with lightning.
20 Monday, . . .	28·290	30	28·286	31	28	27	34	37	33	33	N. W.	0	·050	Cloudy, cold, snow showers.
21 Tuesday, . . .	28·982	33	28·973	35	25	23	33	36	37	36	N. W.	3	·000	Breezy, bright sun, sharp frost.
22 Wednesday, . .	28·850	37	28·831	39	34	32	34	36	40	39	N. W.	2	·090	Breezy, showery, occasional sun.
23 Thursday, . .	29·350	34	29·336	32	29	28	33	36	40	39	S. W.	2	·000	Breezy, cloudy, occasional sun.
24 Friday, ...	29·650	36	29·630	38	32	30	35	37	41	40	N. W.	8	·000	Fine, breezy, bright sunshine.
25 Saturday, . . .	29·700	37	29·680	41	25	23	33	35	42	40	S. E.	0	·000	Breezy, cloudy, sharp frost.
26 Sunday, . . .	29·550	47	29·504	47	41	40	38	39	48	46	S. W.	0	·310	Cloudy, showery, changeable.
27 Monday, . . .	29·892	42	29·856	46	34	32	37	39	47	45	S. E.	3	·000	Cloudy, mild, occasional sunshine.
28 Tuesday, . . .	29·750	43	29·714	43	40	39	37	39	48	42	S. E.	2	·000	Breezy, cloudy, occasional sunshine.
29 Wednesday, . .	29·946	38	29·921	39	38	37	37	38	40	39	S. E.	0	·210	Cloudy, showery, changeable.
30 Thursday, . .	29·946	37	29·926	38	36	35	37	38	39	39	S. E.	0	·000	Cloudy, cold, changeable.
31 Friday, . . .	30·024	37	30·001	38	35	34	36	38	39	39	S. E.	0	·000	Do.
												37	2·800	Inches.

FEBRUARY, 1873.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°		°				
1 Saturday, . . .	29·820	35	29·805	35	35	34	35	37	36	36	S. E.	0	·000	Breezy, cold, light showers.
2 Sunday, . . .	29·440	30	29·436	31	30	29	33	35	32	32	N. E.	0	. .	Breezy, cold, snow showers.
3 Monday, . . .	29·960	27	29·553	30	23	21	31	34	32	32	N. W.	3	. .	Breezy, bright sun, sharp frost.
4 Tuesday, . . .	30·248	33	30·239	39	23	21	32	35	40	39	N. W.	3	. .	Do.
5 Wednesday, . .	30·000	33	29·991	36	27	25	31	33	38	37	S. E.	0	. .	Cloudy, cold, snow showers.
6 Thursday, . .	30·120	35	30·105	38	27	25	32	34	39	38	N.W.	3	. .	Breezy, bright sun, changeable.
7 Friday, ...	30·278	37	30·258	41	31	29	32	34	41	40	S. E.	2	. .	Do.
8 Saturday, . . .	30·300	39	30·274	41	33	31	34	35	43	41	S. E.	3	. .	Do.
9 Sunday, . . .	30·344	39	30·318	42	34	33	35	36	43	42	N. E.	3	. .	Fine, breezy, bright sunshine.
10 Monday, . . .	30·432	40	30·401	42	35	34	35	36	43	42	N. E.	0	·100	Breezy, showery, changeable.
11 Tuesday, . .	30·500	34	30·485	35	33	32	34	36	36	36	S. W.	0	·000	Breezy, cold, changeable.
12 Wednesday, . .	30·300	42	30·264	45	35	34	35	37	45	44	N. E.	4	. .	Fine, breezy, bright sunshine.
13 Thursday, . .	30·272	41	30·241	44	31	29	35	36	45	44	N. W.	0	·040	Cloudy, light showers.
14 Friday, ...	30·300	42	30·264	44	40	39	36	38	45	44	N. W.	0	·000	Breezy, cloudy, changeable.
15 Saturday, . . .	30·400	40	30·369	42	39	38	37	38	43	41	N. W.	0	. .	Do.
16 Sunday, . . .	30·478	42	30·442	44	34	33	37	39	45	44	S. W.	2	. .	Fine, breezy, occasional sunshine.
17 Monday, . . .	30·532	43	30·495	44	40	39	37	39	45	44	S. W.	0	. .	Breezy, cloudy, changeable.
18 Tuesday, . . .	30·620	39	30·594	41	39	38	37	39	42	41	N. W.	0	. .	Do.
19 Wednesday, . .	30·578	42	30·541	44	38	37	38	39	46	44	N. W.	0	. .	Do.
20 Thursday, . .	30·524	44	30·482	49	31	29	38	40	50	49	N. W.	4	. .	Fine, mild, bright sunshine.
21 Friday, ...	30·200	39	30·174	42	28	27	36	38	42	41	S. W.	1	. .	Breezy, cloudy, occasional sun.
22 Saturday, . . .	29·872	39	29·847	41	36	35	36	38	42	41	N. E.	2	·040	Cloudy, light showers, occasional sun.
23 Sunday, . . .	29·640	39	29·615	40	30	29	36	37	41	40	S. W.	0	·030	Breezy, snow showers, changeable.
24 Monday, . . .	29·750	32	29·741	34	27	25	32	35	35	35	S. E.	0	·000	Cloudy, cold, sharp frost.
25 Tuesday, . . .	29·274	43	29·238	46	32	30	34	35	47	46	S. W.	2	·140	Stormy, snow showers, occasional sun.
26 Wednesday, . .	28·772	43	28·738	44	41	40	37	38	45	44	S. W.	0	·030	Breezy, cloudy, light showers.
27 Thursday, . .	29·540	40	29·510	42	36	35	36	38	42	41	S. W.	2	·000	Breezy, cloudy, occasional sunshine.
28 Friday, ...	29·782	40	29·702	43	27	25	35	37	44	42	S. E.	4	. .	Fine, breezy, bright sunshine.
												38	·380	inches.

MARCH, 1873.

DATE. Day, At 12 o'Clock, P.M.	BAROMETER. Observed Height.	Therm.	Corrected for Temperature only.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
		°		°	°	°	°	°	°	°				
1 Saturday, . .	28·932	41	28·903	42	36	35	36	38	42	41	S. E.	0	·180	Breezy, wet, changeable.
2 Sunday, . . .	29·700	45	29·659	48	34	33	37	38	48	47	S. W.	3	·200	Breezy, heavy showers, occasional sun.
3 Monday, . . .	29·570	50	29·513	52	42	40	38	39	53	51	S. W.	0	·110	Breezy, cloudy, showery, changeable.
4 Tuesday, . . .	29·696	52	29·684	54	46	44	42	43	55	53	S. W.	4	·000	Fine, breezy, bright sunshine.
5 Wednesday, .	29·994	46	29·948	48	39	38	42	43	50	48	N. E.	4	. .	Do.
6 Thursday, . .	29·700	42	29·700	44	31	30	39	41	44	43	S. W.	0	·050	Breezy, cloudy, light showers.
7 Friday, . . .	29·250	43	29·215	45	40	39	39	41	46	44	S. W.	4	·500	Breezy, heavy rain, bright sunshine.
8 Saturday, . .	29·450	44	29·410	47	36	34	38	40	46	47	S. W.	3	·000	Breezy, cloudy, occasional sunshine.
9 Sunday, . . .	29·150	40	29·121	42	36	34	38	40	43	42	S. W.	2	·040	Breezy, showery, occasional sunshine.
10 Monday, . . .	29·272	39	29·247	43	33	31	38	39	44	43	S. W.	3	·000	Breezy, cloudy, occasional sunshine.
11 Tuesday, . . .	29·100	44	29·060	45	34	33	38	39	47	46	S. W.	3	·100	Stormy, showery, occasional sunshine.
12 Wednesday, . .	29·450	41	29·420	42	31	29	36	38	42	41	N. E.	2	·080	Breezy, snow showers, occasional sun.
13 Thursday, . .	29·680	40	29·650	41	30	28	36	38	42	41	N. E.	2	·080	Do.
14 Friday, . . .	29·772	40	29·742	42	33	31	36	37	43	42	N. E.	3	·050	Do.
15 Saturday, . .	29·936	41	29·906	42	36	34	36	37	43	42	N. E.	2	·070	Do.
16 Sunday, . . .	29·800	38	29.775	39	35	34	36	38	40	39	N. E.	0	·040	Breezy, cloudy, snow showers.
17 Monday, . . .	29·848	37	29·825	39	34	33	36	38	39	38	S. W.	0	·320	Cloudy, wet, changeable.
18 Tuesday, . . .	30·036	40	30·005	42	36	35	36	38	43	42	N. E.	1	·000	Breezy, cloudy, occasional sunshine.
19 Wednesday, .	30·036	42	30·000	45	34	33	38	39	46	44	N. E.	0	·040	Breezy, cloudy, light showers.
20 Thursday, . .	30·136	39	30.105	41	34	33	38	39	42	40	N. E.	2	·000	Breezy, cloudy, occasional sun.
21 Friday, . . .	30·100	42	30·064	43	38	36	38	39	44	42	N. E.	3	. .	Do.
22 Saturday, . .	29·940	42	29·904	44	37	35	38	39	45	44	N. E.	2	. .	Do.
23 Sunday, . . .	29·980	42	29·944	43	35	34	38	39	44	43	N. E.	0	. .	Breezy, cloudy, changeable.
24 Monday, . . .	30·050	44	30·042	48	32	31	39	41	49	47	N. E.	2	. .	Breezy, cloudy, occasional sunshine.
25 Tuesday, . .	30·050	46	30·008	49	39	37	40	42	50	48	N. E.	1	·110	Breezy, showery, occasional sunshine.
26 Wednesday, .	30·050	53	29·987	54	36	35	42	43	55	53	N. E.	3	·000	Breezy, cloudy, occasional sunshine.
27 Thursday, . .	29·900	52	29·588	53	45	43	43	44	54	52	N. E.	3	. .	Do.
28 Friday, . . .	29·800	47	29·756	49	44	42	43	44	51	49	S. E.	0	. .	Breezy, cloudy, changeable.
29 Saturday, . .	29·900	52	29·838	55	44	42	44	45	54	51	S. E.	5	. .	Fine, breezy, bright sunshine.
30 Sunday, . . .	29·800	49	29·754	49	43	41	44	45	49	46	S. E.	0	·100	Breezy, showery, changeable.
31 Monday, . . .	29·540	45	29·499	47	43	41	44	45	40	46	S. E.	0	·150	Do.
												57	2·170	Inches.

APRIL, 1873.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	Therm.	Corrected for Temperature only.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH	WEATHER, AND GENERAL REMARKS.
		°		°	°	°	°	°	°	°				
1 Tuesday, . .	29·950	44	29 909	46	43	41	44	45	47	46	S. E.	0	·150	Breezy, showery, changeable.
2 Wednesday, .	30·150	48	30·098	51	31	30	41	43	52	50	S. W.	4	·000	Fine, breezy, bright sun.
3 Thursday, . .	30 170	51	30·112	53	45	43	43	44	53	51	S. W.	2	·070	Breezy, showery, occasional sun.
4 Friday, . . .	30·028	52	29·965	53	43	41	43	42	53	51	S. W.	0	·080	Breezy, showery, changeable.
5 Saturday, . .	29·892	47	29·846	49	43	41	43	42	50	40	S. W.	0	·050	Do.
6 Sunday, . . .	29·850	48	29 798	51	37	36	41	42	51	49	S. W.	2	·020	Breezy, showery, occasional sunshine.
7 Monday, . .	30·000	48	29·948	49	36	35	41	43	50	48	S. W.	3	·020	Do.
8 Tuesday, . .	30·228	47	30·168	50	34	32	41	43	51	48	S. W	5	·000	Fine, breezy, bright sunshine.
9 Wednesday, .	30·392	51	30·334	53	36	34	42	44	55	53	N. E.	3	..	Breezy, cloudy, occasional sun.
10 Thursday, . .	30·392	47	30·345	49	43	41	44	45	50	49	N. E.	3	..	Do.
11 Friday, . . .	30·180	50	30·122	53	34	32	43	45	55	52	N. E.	2	..	Do.
12 Saturday, . .	30·050	48	29·998	50	38	36	43	45	51	49	N. E.	3	..	Do.
13 Sunday, . . .	29·800	48	29·748	51	38	36	44	45	52	50	N E.	2	..	Breezy, cloudy, occasional sunshine.
14 Monday, . . .	29·700	49	29·648	50	45	43	44	45	51	49	N. E.	0	..	Breezy, cloudy, rain-like day.
15 Tuesday, . .	29·650	55	29·573	57	46	44	45	46	58	55	S. E.	0	..	Do.
16 Wednesday, .	29·536	52	29·464	54	45	43	47	48	56	54	S. E.	2	..	Cloudy, mild, occasional sunshine.
17 Thursday, .	29·536	48	29·474	48	44	42	47	48	49	47	N. E.	0	·030	Breezy, cloudy, light showers.
18 Friday, . . .	29·838	53	29·766	55	45	43	47	48	57	54	N. E.	3	·150	Breezy, showery, occasional sunshine.
19 Saturday, . .	30·150	56	30·076	58	37	35	48	49	61	58	S. E.	6	·000	Fine, breezy, bright sunshine.
20 Sunday, . . .	30·240	56	30·193	56	37	35	47	49	56	54	S. E.	0	..	Do.
21 Monday, . .	30·292	59	30·113	59	37	35	47	49	61	58	N. E.	0	..	Do.
22 Tuesday, . .	30·050	53	29·987	53	35	34	45	47	53	51	N. E.	4	..	Breezy, cloudy, occasional sun.
23 Wednesday, .	30·050	44	30·008	46	39	37	44	47	47	46	N. E.	4	..	Do.
24 Thursday, . .	30·050	44	30·008	47	34	33	44	47	49	48	N. E.	4	·020	Breezy, light showers, occasional sun.
25 Friday, . . .	30·200	45	30·158	47	31	29	43	45	48	47	N. E.	4	·000	Breezy, cloudy, occasional sun.
26 Saturday, . .	30·300	47	30·253	49	31	29	43	45	51	49	N. E.	3	..	Do.
27 Sunday, . . .	30·150	52	30·078	55	41	39	44	45	55	53	N.E.	4	..	Do.
28 Monday, . .	30·236	50	30·178	51	40	38	44	45	52	51	N. E.	2	.	Do.
29 Tuesday, . .	30·236	52	30·178	53	44	42	44	46	54	51	N. E.	2	·030	Breezy, light shower, occasional sun.
30 Wednesday, .	30·200	53	30·173	54	46	44	46	48	55	58	N. W.	0	·000	Breezy, cloudy, occasional sunshine.
												67	620	inches.

MAY, 1873.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In earth. 5 in.	In earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Thursday, . . .	30·200	56	30·126	57	48	46	48	49	58	55	N. W.	4	·000	Fine, breezy, bright sunshine.
2 Friday, ...	29·950	56	29·876	58	45	43	48	49	59	56	N. W.	4	. .	Do.
3 Saturday, . . .	29·800	54	29·733	55	45	43	48	49	56	54	N. W.	4	. .	Do.
4 Sunday, . . .	29·740	52	29·678	54	34	32	45	47	54	52	S. W.	5	. .	Fine, breezy, bright sunshine.
5 Monday, . . .	29·350	48	29·298	50	44	42	47	49	51	49	S. W	5	·100	Breezy, showery, occasional sun.
6 Tuesday, . . .	29·350	45	29·305	46	37	35	43	46	47	46	S. W.	3	.090	Do.
7 Wednesday, . .	29·400	47	29·359	47	38	36	48	46	47	46	S. W.	2	.110	Do.
8 Thursday, . . .	29·640	52	29·583	53	40	38	45	47	54	51	S. W.	2	·100	Do.
9 Friday, ...	29·950	53	29·888	54	44	42	46	48	55	52	S. W.	3	·050	Do.
10 Saturday, . . .	30·028	53	29·965	57	37	36	47	48	58	55	S. E.	0	·000	Breezy, cloudy, rain-like day.
11 Sunday, . . .	30·126	58	30·047	60	51	49	48	50	61	58	S. W.	4	·250	Breezy, heavy showers, occasional sunshine.
12 Monday, . . .	30·228	58	30·149	61	43	41	49	51	62	59	S. E.	6	·000	Fine, breezy, bright sunshine.
13 Tuesday, . . .	30·200	57	30·126	57	42	40	49	51	58	56	S. E.	6	. .	Do.
14 Wednesday, . .	30·150	54	30·082	55	38	36	49	51	55	53	S. E.	5	. .	Do.
15 Thursday, . . .	30·038	55	29·970	55	45	43	50	51	55	53	N. E.	0	. .	Cloudy, mild, changeable.
16 Friday, ...	29·900	54	29·833	55	47	45	50	51	56	54	N. E.	1	. .	Do.
17 Saturday, . . .	29·650	52	29·593	53	44	42	49	51	53	51	N. E.	2	. .	Breezy, cloudy, occasional sun.
18 Sunday, . . .	29·750	44	29·709	45	43	41	47	49	45	43	N. E	0	·120	Breezy, showery, changeable.
19 Monday, . . .	30·050	49	29·998	51	34	32	45	47	52	50	N. E.	5	·000	Breezy, cloudy, occasional sunshine.
20 Tuesday, . . .	30·100	54	30·032	57	33	31	45	48	58	55	S. W.	4	. .	Do.
21 Wednesday, . .	29·950	59	29·872	61	50	48	49	50	52	59	S. W.	4	. .	Do.
22 Thursday, . . .	29·850	57	29·877	58	47	45	49	50	59	56	S. W.	3	·020	Breezy, light showers, occasional sun.
23 Friday, ...	29·646	60	29·568	61	52	50	52	53	62	58	S. W.	4	·080	Do.
24 Saturday, . . .	30·128	55	30·060	56	39	37	48	50	57	55	N. W.	4	·000	Fine, breezy, bright sunshine.
25 Sunday, . . .	30·200	58	30·137	53	35	33	48	50	53	51	S. E.	4	. .	Breezy, cloudy, occasional sunshine.
26 Monday, . . .	29·950	61	29·867	63	48	46	50	52	64	60	N. W.	7	·060	Breezy, light showers, bright sun.
27 Tuesday, . . .	29·824	59	29·746	60	49	47	52	53	62	59	N. E.	8	·070	Cloudy, light showers, occasional sun.
28 Wednesday, . .	30·280	63	30·190	64	42	40	54	55	65	61	S. E.	7	·000	Fine, breezy, bright sunshine.
29 Thursday, . . .	30·350	62	30·260	62	43	41	53	55	63	60	S. E.	7	. .	Do.
30 Friday, ...	30·300	62	30·210	62	51	49	55	56	63	60	S E.	4	. .	Cloudy, mild, occasional sunshine.
31 Saturday, . . .	30·200	59	30·121	59	52	50	54	56	59	56	S. E.	0	·020	Cloudy, mild, light showers.
												112	1·020	

JUNE, 1873.

DATE.	BAROMETER.			THERMOMETER.							WIND.		RAIN	
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.	HOURS OF SUNSHINE.	IN INCH.	WEATHER, AND GENERAL REMARKS.
		°		°	°	°	°	°	°	°				
1 Sunday, . . .	30·150	63	30·060	63	47	45	53	55	64	61	N. E.	6	. .	Fine, breezy, bright sun.
2 Monday, . .	30·228	60	30·141	60	45	43	52	54	61	58	N. E.	6	. .	Do.
3 Tuesday, . . .	29·950	58	29·872	59	50	48	55	57	60	57	N. E.	2	. .	Breezy, cloudy, occasional sun.
4 Wednesday, .	29·840	62	29·752	63	52	50	55	57	64	60	N. E.	6	. .	Fine, breezy, bright sun.
5 Thursday, . .	29·950	67	29·849	68	43	41	57	58	71	68	N. E.	6	. .	Do.
6 Friday, . . .	30·20[illegible]	59	30·121	61	53	51	56	58	63	60	N. E.	1	. .	Breezy, cloudy, changeable.
7 Saturday, . .	30·338	62	30·248	63	45	43	55	57	64	61	N. E.	0	. .	Do.
8 Sunday, . . .	30·288	60	30·143	61	53	51	56	57	62	59	N. W.	4	. .	Breezy, cloudy, occasional sunshine.
9 Monday, . . .	29·950	62	29·862	63	50	48	56	57	64	61	S. W.	8	. .	Do.
10 Tuesday, . . .	29·550	63	29·462	63	52	50	55	57	64	61	S. W.	4	·100	Breezy, light showers, occasional sun.
11 Wednesday, .	29·500	61	29·417	62	46	44	55	57	64	61	S. W.	3	.	Breezy, cloudy, occasional sunshine.
12 Thursday, . .	29·546	55	29·479	57	51	49	54	56	58	56	S. E.	0	·300	Cloudy, heavy showers, changeable.
13 Friday, . . .	29·690	60	29·607	61	46	·44	53	55	63	60	S. W.	6	. .	Fine, breezy, bright sunshine.
14 Saturday, . .	29·750	57	29·677	57	49	47	53	55	57	55	N. E.	0	·090	Cloudy, showery, changeable.
15 Sunday, . . .	29·812	62	29·724	62	45	44	54	56	63	60	S. E.	3	·070	Breezy, light showers, occasional sun.
16 Monday, . . .	29·940	60	29·857	61	42	40	54	56	62	59	S. W.	4	·290	Breezy, heavy showers, occasional sun.
17 Tuesday, . .	29·940	60	29·857	61	48	46	52	55	62	59	N. E.	0	. .	Breezy, cloudy, changeable.
18 Wednesday, .	29·972	66	29·873	66	54	51	55	57	66	62	N. E.	6	·040	Breezy, light showers, bright sun.
19 Thursday, . .	29·800	62	29·712	63	54	51	56	57	65	62	S. E.	0	.	Breezy, cloudy, changeable.
20 Friday, . . .	30·092	71	29·981	73	53	50	58	58	74	70	S. E.	8	. .	Fine, breezy, bright sunshine.
21 Saturday, . .	30·200	70	30·089	70	56	53	59	60	71	67	S. E.	6	. .	Fine, mild, occasional sunshine.
22 Sunday, . . .	29·950	66	29·851	66	62	59	61	62	68	64	S. E.	2	. .	Breezy, cloudy, occasional sun.
23 Monday, . .	30·050	60	29·965	59	50	48	56	59	60	58	S. W.	3	. .	Do.
24 Tuesday, . .	29·950	64	29·856	66	56	53	58	59	68	64	S. W.	1	. .	Do.
25 Wednesday, .	30·078	62	29·988	62	53	50	56	58	63	60	S. W.	5	. .	Fine, breezy, bright sunshine.
26 Thursday, . .	30·094	61	30·009	61	50	48	55	58	62	60	S. W.	0	·030	Breezy, cloudy, light showers.
27 Friday, . .	30·040	65	29·945	67	56	53	58	59	68	65	S. W.	2	·000	Breezy, cloudy, occasional sunshine.
28 Saturday, . .	29·950	61	29·867	61	57	54	57	59	62	60	S. W.	0	·020	Breezy, cloudy, light showers.
29 Sunday, . . .	29·800	60	29·717	60	51	49	56	58	61	59	N. E.	0	·150	Cloudy, showery, changeable.
30 Monday, . .	29·944	65	29·850	65	46	44	57	58	65	62	N. W.	4	·060	Cloudy, light showers, occasional sun.
												91	1·150	inches.

JULY, 1873.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in	Dry.	Wet	Direction.			
		°		°	°	°	°	°	°	°				
1 Tuesday, . . .	30·028	62	29·938	63	51	48	57	59	64	61	S. W.	0	. .	Cloudy, mild, changeable.
2 Wednesday, . .	29·928	69	29·819	70	58	55	58	60	72	68	S. W.	0	. .	Do.
3 Thursday, . .	29·580	60	29·497	60	58	55	58	60	61	59	S. W.	0	·030	Cloudy, light showers, changeable.
4 Friday, . . .	29·600	59	29·522	60	51	49	56	58	62	60	S. W.	2	·040	Breezy, hail showers, occasional sun.
5 Saturday, . .	29·550	55	29·483	55	50	48	55	58	56	54	S. E.	0	·070	Breezy, showery, changeable.
6 Sunday, . . .	29·830	64	29·736	66	50	48	56	58	67	64	S. W.	6	·040	Breezy, light showers, bright sun.
7 Monday, . . .	29·900	69	29·769	69	55	52	58	59	70	67	S. W.	7	. .	Fine, breezy, bright sunshine.
8 Tuesday, . . .	29·988	62	29·900	66	56	53	60	62	69	66	S. W.	2	·260	Breezy, showery, occasional sun.
9 Wednesday, .	30·040	63	29·950	63	57	49	58	60	64	61	S. W.	2	. .	Breezy, cloudy, changeable.
10 Thursday, . .	29·820	63	29·732	63	55	52	58	60	64	61	S. W.	2	·080	Breezy, showery, occasional sun.
11 Friday, . . .	29·750	62	29·662	64	53	50	58	59	65	62	S. W.	2	. .	Do.
12 Saturday, . .	29·592	62	29·504	63	49	47	56	59	65	62	S. W.	3	·090	Cloudy, showery, occasional sun.
13 Sunday, . . .	29·550	61	29·467	62	47	45	56	58	63	60	S. E.	3	·360	Breezy, heavy showers, thunder, occas. sun.
14 Monday, . . .	29·564	64	29·470	67	46	44	56	58	69	66	S. W.	6	·080	Fine, breezy, bright sun, light showers.
15 Tuesday, . . .	29·700	61	29·617	61	50	48	55	57	63	60	S. W.	3	·120	Breezy, showery, occasional sunshine.
16 Wednesday, . .	30·100	63	30·010	65	46	44	55	57	65	62	S. W.	4	·100	Do.
17 Thursday, . .	29·850	67	29·751	68	49	47	57	58	68	65	S. E.	0	. .	Breezy, cloudy, changeable.
18 Friday, . . .	29·842	61	29·759	61	55	43	57	58	62	60	S. W.	3	·220	Breezy, showery, occasional sun.
19 Saturday, . .	30·042	59	29·963	61	50	48	57	58	62	60	S. W.	0	. .	Breezy, cloudy, changeable.
20 Sunday, . . .	30·050	76	29·917	78	60	56	61	61	80	76	S. W.	7	. .	Fine, breezy, warm, bright sunshine.
21 Monday, . . .	30·096	72	29·985	72	53	50	61	62	72	69	S. W.	7	. .	Do.
22 Tuesday, . . .	29·950	71	29·841	74	60	57	61	62	75	71	S. W.	2	. .	Cloudy, changeable, occasional sun.
23 Wednesday, . .	29·980	64	29·886	66	56	53	61	63	66	63	S. W.	2	·700	Thunder, lightning, heavy rain, hot sun.
24 Thursday, . .	29·850	64	29·756	66	52	49	60	62	67	63	S. W.	1	·180	Cloudy, showery, occasional sunshine.
25 Friday, . . .	29·888	64	29·794	66	54	51	60	62	68	64	S. E.	3	·070	Do.
26 Saturday, . .	29·862	64	29·768	65	55	52	60	62	66	63	S. W.	2	. .	Cloudy, mild, occasional sunshine.
27 Sunday, . . .	29·862	63	29·774	64	54	51	59	61	65	62	S. W.	1	·280	Cloudy, showery, occasional sun.
28 Monday, . . .	29·978	64	29·884	68	52	49	59	61	65	62	S. W.	8	·440	Thunder, lightning, heavy showers, occas. [sun.
29 Tuesday, . . .	29·900	64	29·817	66	54	51	59	61	65	62	S. W.	1	·100	Cloudy, showery, occasional sunshine.
30 Wednesday, . .	29·810	64	29·716	64	53	50	59	61	66	62	S. W.	1	·110	Do.
31 Thursday, . .	29·828	67	29·727	68	55	52	59	61	69	66	S. W.	8	·300	Do.
												78	3·070	Inches.

AUGUST, 1873.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Friday, ...	30·116	63	30·026	63	53	49	59	60	64	61	S. W.	3	·050	Cloudy, showery, occasional sunshine.
2 Saturday, . . .	30·130	63	30·040	63	58	49	58	60	64	61	S. W.	2	. .	Breezy, cloudy, occasional sunshine.
3 Sunday, . . .	30·140	62	30·050	68	54	51	58	60	65	62	S. W.	3	. .	Fine, breezy, occasional sunshine.
4 Monday, . . .	29·950	64	29·856	64	54	51	58	60	65	62	S. W.	0	·190	Cloudy, showery, changeable.
5 Tuesday, . . .	29·972	66	29·878	66	50	47	58	60	66	63	S. E.	3	. .	Breezy, cloudy, occasional sun.
6 Wednesday, . .	29·886	67	29·787	67	58	55	59	61	68	65	S. W.	3	. .	Do.
7 Thursday, . . .	30·050	70	29·939	71	61	58	62	63	72	68	S. W.	6	. .	Fine, breezy, bright sunshine.
8 Friday, ...	29·900	60	29·817	61	58	55	59	61	62	59	S. W.	0	·200	Cloudy, wet, changeable.
9 Saturday, . . .	30·050	62	29·960	63	48	46	59	61	64	62	S. W.	5	·030	Breezy, light showers, occasional sun.
10 Sunday, . . .	30·060	58	29·981	60	50	48	56	58	60	58	S. W.	2	. .	Breezy, cloudy, occasional sun.
11 Monday, . . .	29·950	62	29·862	63	54	51	59	60	64	61	S. W.	2	·150	Cloudy, showery, occasional sun.
12 Tuesday, . . .	29·980	62	29·892	64	56	54	58	59	64	61	S. W.	0	. .	Breezy, cloudy, changeable.
13 Wednesday, . .	30·000	63	29·904	64	54	51	58	59	65	62	S. W.	6	. .	Fine, breezy, bright sunshine.
14 Thursday, . . .	30·050	64	29·955	65	51	48	57	58	66	63	S. W.	6	. .	Do.
15 Friday, ...	30·000	64	29·905	64	51	48	58	60	65	62	S. W.	4	. .	Cloudy, mild, occasional sun.
16 Saturday, . . .	29·722	64	29·628	64	52	50	59	61	65	62	S. W.	2	·440	Breezy, heavy showers, occasional sun.
17 Sunday, . . .	30·040	57	29·960	58	47	45	55	57	58	56	S. W.	0	·080	Cloudy, showery, changeable.
18 Monday, . . .	29·600	64	29·506	66	58	50	55	57	66	63	S. W.	4	·320	Breezy, heavy showers, occasional sun.
19 Tuesday, . . .	29·700	57	29·627	59	50	48	55	57	60	58	N. E.	1	·220	Do.
20 Wednesday, . .	29·522	62	29·434	64	49	47	55	57	65	62	S. W.	1	·140	Do.
21 Thursday, . . .	29·700	63	29·612	64	52	49	56	58	66	63	S. W.	3	. .	Cloudy, mild, occasional sunshine.
22 Friday, ...	29·778	64	29·684	66	52	49	56	58	66	63	S. W.	3	·040	Cloudy, light showers, occasional sun.
23 Saturday, . . .	29·778	61	29·695	61	53	50	55	57	62	60	S. E.	0	. .	Breezy, cloudy, changeable.
24 Sunday, . . .	29·850	60	29·772	60	56	53	57	59	60	58	S. E.	0	·700	Cloudy, heavy showers, changeable.
25 Monday, . . .	29·876	65	29·782	66	56	53	59	60	67	64	S.	3	·660	Breezy, heavy showers, occasional sun.
26 Tuesday, . . .	29·600	60	29·515	61	58	50	58	59	62	59	S. E.	2	·440	Breezy, heavy showers, thunder, lightning.
27 Wednesday, . .	29·700	62	29·612	62	53	50	57	59	63	60	S.	3	. .	Cloudy, mild, occasional sunshine.
28 Thursday, . . .	29·400	59	29·323	61	51	49	57	59	63	60	S. W.	1	520	Breezy, heavy rain, occasional sun.
29 Friday, . .	29·612	54	29·545	57	46	44	53	56	58	56	S. W.	1	·060	Breezy, light showers, occasional sun.
30 Saturday, . . .	29·762	63	29·674	65	47	45	54	57	66	63	S. W.	6	. .	Fine, mild, bright sunshine.
31 Sunday, . . .	29·724	61	29·641	62	56	53	56	58	63	60	S. E.	0	·020	Cloudy, mild, light showers.
												75	4 260	inches.

SEPTEMBER, 1873.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	Therm	Corrected for Temperature on .	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
		°		°		°	°	°	°	°				
1 Monday, . . .	29·640	63	29·552	65	53	50	56	58	66	63	S. W.	5	. .	Fine, breezy, bright sunshine.
2 Tuesday, . . .	29·878	57	29·805	57	49	47	55	57	68	56	S. W.	1	·030	Breezy, light showers, occasional sun.
3 Wednesday, . .	30·098	55	30·024	56	49	47	53	56	57	55	N. W.	0	·060	Breezy, light showers, changeable.
4 Thursday, . .	30·170	59	30·091	59	50	48	54	57	60	58	S. W.	2	. .	Breezy, cloudy, occasional sun.
5 Friday, . . .	30·060	58	29·981	59	47	45	52	54	60	58	S. W.	2	. .	Do.
6 Saturday, . .	30·000	52	29·937	52	48	46	51	54	53	51	N. W.	0	. .	Cloudy, calm, changeable.
7 Sunday, . . .	29·726	57	29·653	59	47	45	53	55	61	59	S. E.	2	·030	Cloudy, light showers, occasional sun.
8 Monday, . . .	29·840	59	29·762	61	45	43	53	55	62	60	N. W.	2	. .	Cloudy, mild, occasional sunshine
9 Tuesday, . . .	29·490	59	29·413	61	49	47	53	56	62	60	S. W.	1	·390	Breezy, wet, changeable.
10 Wednesday, .	29·640	60	29·557	60	50	48	53	56	62	60	S. W.	3	. .	Breezy, cloudy, occasional sunshine.
11 Thursday, . .	29·746	59	29·668	60	46	44	52	55	61	59	S. W.	3	. .	Do.
12 Friday, . .	29·800	60	29·717	61	48	46	52	55	61	59	S. W.	3	. .	Do.
13 Saturday, . .	29 800	54	29·733	56	44	42	52	54	56	54	S. E.	1	·060	Cloudy, showery, occasional sun.
14 Sunday, . . .	29·440	58	29·363	61	42	40	51	53	62	60	S. E.	5	1·340	Cloudy, heavy rain, bright sun.
15 Monday, . . .	29·440	53	29·379	53	47	45	50	52	53	51	S. E.	0	·200	Breezy, heavy showers, changeable.
16 Tuesday, . . .	29·728	58	29·655	57	42	40	49	52	58	56	S. W.	2	.	Breezy, cloudy, occasional sunshine.
17 Wednesday, . .	29·600	61	29·517	62	54	50	54	55	63	60	S. W.	0	·030	Breezy, changeable, light showers.
18 Thursday, . .	29·864	57	29·791	57	46	44	51	53	58	56	S. W.	5	. .	Fine, breezy, bright sunshine.
19 Friday, . . .	29·946	53	29·884	54	46	44	50	52	56	54	S. E.	0	·030	Breezy, cloudy, light showers.
20 Saturday, . .	29·872	63	29·784	63	53	50	54	55	63	60	S. W.	0	·040	Do.
21 Sunday, . . .	30·384	56	30·310	58	43	41	53	54	59	57	N. E.	3	. .	Cloudy, mild, occasional sun.
22 Monday, . . .	30·500	57	30·425	59	34	32	50	53	61	59	S. E.	6	. . .	Fine, mild, bright sunshine.
23 Tuesday, . . .	30 400	58	30·321	61	40	38	50	52	62	60	S. E.	6	. .	Do.
24 Wednesday, . .	30·308	61	30·223	63	41	39	51	53	65	62	S. E.	6	. .	Do.
25 Thursday, . .	30·150	62	30·060	65	45	48	58	54	67	64	S. E.	6	. .	Do.
26 Friday, . . .	30·072	65	29·977	65	51	48	54	55	66	63	S. E.	6	. .	Fine, breezy, bright sunshine.
27 Saturday, . .	29·820	71	29·711	71	57	54	56	57	71	68	S. W.	6	. .	Do.
28 Sunday, . . .	30·040	56	29·966	57	42	40	53	55	58	56	N. W.	6	. .	Fine, breezy, bright sun.
29 Monday, . . .	30·180	54	30 112	57	33	31	50	52	59	57	S. E.	6	. .	Do.
30 Tuesday, . . .	29·900	55	29 838	56	38	36	49	51	56	54	S. E.	0	·110	Cloudy, showery, and changeable.
												88	3·220	Inches.

OCTOBER, 1873.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Wednesday, .	29·800	65	29·704	68	54	52	54	55	69	66	S. W.	3	·200	Breezy, showery, occasional sun.
2 Thursday, . .	29·850	65	29·756	66	57	54	56	57	66	64	S. W.	1	·210	Do.
3 Friday, . . .	29·690	62	29·602	68	56	53	56	57	64	63	S. E.	0	·240	Cloudy, showery, mild, changeable.
4 Saturday, . .	30·050	58	29·971	58	48	45	54	56	59	57	N. E.	4	·130	Breezy, showery, occasional sun.
5 Sunday, . .	30·000	53	29·937	54	48	46	51	53	55	53	S. W.	0	·000	Breezy, cloudy, changeable.
6 Monday, . .	29·728	54	29·661	55	45	43	51	58	56	54	S. W.	0	. .	Do.
7 Tuesday, . .	29·674	52	29·612	53	41	39	49	51	54	52	S. W.	3	·060	Cloud, hail, showers, occasional sun.
8 Wednesday, .	29·750	48	29·698	50	35	33	47	49	51	50	S. W.	2	·040	Do.
9 Thursday, . .	29·480	51	29·424	53	35	33	47	49	54	52	S. W.	1	·350	Breezy, wet, changeable.
10 Friday, . .	29·528	59	29·450	69	52	50	50	52	61	59	S. W.	2	·110	Breezy, showery, occasional sun.
11 Saturday, . .	29·550	52	29·488	52	49	47	50	52	53	51	S. W.	0	·090	Breezy, showery, changeable.
12 Sunday, . .	29·600	49	29·548	53	40	38	48	50	54	52	S. W.	4	·000	Fine. breezy, bright sunshine.
13 Monday, . .	29·600	47	29·554	50	39	37	46	49	51	49	S. W.	4	. .	Do.
14 Tuesday, . .	29·800	45	29·759	48	36	34	44	47	50	48	S. W.	4	. .	Do.
15 Wednesday, .	29·900	49	29·848	52	31	29	44	46	54	52	S. E.	3	.	Cloudy, mild, occasional sun.
16 Thursday, . .	29·928	55	29·841	56	45	43	46	48	58	56	S. E.	0	·030	Cloudy, light showers.
17 Friday, . . .	30·000	53	29·937	54	48	46	47	49	55	53	S. W.	0	·000	Cloudy, calm, changeable.
18 Saturday, . .	29·988	54	29·931	55	50	48	49	50	56	54	S. W.	2	·040	Breezy, light showers, occasional sun.
19 Sunday, . .	30·200	52	30·164	54	40	38	47	49	56	54	S. W.	3	·000	Fine, calm, bright sunshine.
20 Monday, . .	29·900	46	29·854	46	40	38	46	48	47	46	S. W.	2	·060	Breezy, showery, occasional sunshine.
21 Tuesday, . .	29·490	49	29·439	50	38	36	44	46	51	49	S. W.	0	·070	Breezy, showery, changeable.
22 Wednesday, .	29·040	46	29·001	46	45	44	44	46	47	46	S. W.	0	·230	Do.
23 Thursday, . .	28·850	42	28·816	44	35	33	42	47	45	44	S. W.	0	·060	Do.
24 Friday, . . .	29·140	38	29·088	39	31	29	39	41	40	39	S. W.	0	·500	Breezy, wet, changeable.
25 Saturday, . .	29·600	44	29·559	48	33	31	40	42	50	49	S. W.	3	·840	Heavy rain, bright sun.
26 Sunday, . .	29·940	42	29·904	48	29	27	39	41	51	49	N. W.	3	·000	Fine, bright sun, light frost.
27 Monday, . .	30·372	42	30·336	47	29	27	39	41	50	48	N. W.	3	. .	Do.
28 Tuesday, . .	30·372	45	30·330	52	28	26	39	41	54	52	S. W.	3	. .	Do.
29 Wednesday, .	30·100	50	30·042	53	38	36	41	43	54	52	S. W.	2	. .	Breezy, cloudy, occasional sun.
30 Thursday, .	29·800	48	29·748	50	46	44	43	44	51	49	S. W.	2	. .	Do.
31 Friday, . .	29·390	48	29·339	49	34	32	42	43	50	49	S. W.	1	·070	Breezy, cloudy, light showers.
												55	3·370	inches.

NOVEMBER, 1873.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	Therm.	Corrected for Temperature only.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
		°		°	°	°	°	°	°	°				
1 Saturday, . .	28·950	44	28·910	46	40	38	42	43	47	46	S. W.	2	·230	Stormy, heavy showers. occasional sun.
2 Sunday, . . .	29·092	39	29·067	45	29	28	39	42	47	45	N. W.	4	·000	Fine, bright sun, light frost.
3 Monday, . . .	29·328	37	29·300	42	25	24	37	39	44	43	N. W.	8	. .	Do.
4 Tuesday, . . .	29·350	34	29·336	39	27	25	36	38	42	41	N. E.	8	. .	Do.
5 Wednesday, . .	29·330	48	29·278	53	39	38	40	42	55	53	N. E.	8	·270	Breezy, showery, bright sun.
6 Thursday, . . .	29·450	47	29·405	47	43	41	41	43	48	47	N. E.	0	·550	Breezy, wet, changeable.
7 Friday, ...	29·750	42	29·714	43	41	40	40	42	45	46	N. E.	0	·100	Breezy, showery, changeable.
8 Saturday, . . .	30·100	44	30·058	45	42	40	41	43	46	45	N. E.	0	·070	Do.
9 Sunday, . . .	30·150	48	30·098	48	40	38	42	43	49	48	N. E.	2	·070	Breezy, showery, occasional sun.
10 Monday, . . .	30·088	45	30·046	46	43	41	41	42	47	46	N. E.	0	·060	Breezy, showery, changeable.
11 Tuesday, . . .	30·200	47	30·153	49	45	43	43	44	51	49	N. E.	2	·030	Cloudy, showery, occasional sun.
12 Wednesday, . .	30·050	43	30·014	44	38	36	41	43	45	44	N. E.	0	010	Breezy, cloudy, changeable.
13 Thursday, . . .	29·774	43	29·738	45	39	37	41	43	45	44	N. E.	0	. .	Do.
14 Friday, . . .	29·980	46	29·934	46	44	42	42	43	47	46	N. E.	0	·400	Breezy, wet, changeable.
15 Saturday, . . .	30·320	45	30·258	47	48	41	43	44	49	48	N. E.	2	·000	Fine, breezy, bright sunshine.
16 Sunday, . . .	30·040	43	30·404	45	36	34	41	42	46	45	N. E.	0	. .	Cloudy, calm, changeable.
17 Monday, . . .	30·040	42	30·404	43	41	39	40	42	43	42	N. E.	0	. .	Do.
18 Tuesday, . . .	30·316	40	30·285	41	40	38	39	41	42	41	N. E.	0	. .	Do.
19 Wednesday, . .	30·100	44	30·058	45	41	39	41	43	46	45	S. E.	0	. .	Do.
20 Thursday, . .	30·050	44	30·008	46	43	41	41	43	46	45	N. W.	0	. .	Do.
21 Friday, ...	29·700	43	29·664	45	32	31	40	41	46	45	S. W.	0	·110	Breezy, showery, changeable.
22 Saturday, . . .	29·600	51	29·543	51	44	42	42	44	52	50	S. W.	2	·000	Breezy, cloudy, occasional sun.
23 Sunday, . . .	29·740	48	29·688	49	45	43	43	45	50	49	S. W.	1	. .	Do.
24 Monday, . . .	29·790	47	29·744	48	44	42	43	45	49	48	S. W.	1	. .	Do.
25 Tuesday, . . .	29·976	44	29·935	47	37	36	41	43	48	47	S. E.	0	. .	Breezy, cloudy, changeable.
26 Wednesday, . .	29·300	52	29·249	58	47	45	45	47	54	52	S. E.	0	·100	Breezy, showery, changeable.
27 Thursday, . .	29·450	45	29·410	47	42	40	43	45	48	47	S. W.	2	·280	Breezy, showery, occasional sun.
28 Friday, . . .	29·850	52	29·788	58	41	40	43	45	54	52	S. W.	0	·080	Breezy, light showers.
29 Saturday, . . .	29·500	51	29·443	51	50	48	45	47	51	49	S. W.	0	·020	Do.
30 Sunday, ...	30·100	46	30·053	48	40	38	43	45	49	48	N. W.	2	·000	Fine, breezy, bright sunshine.
												29	2·320	Inches.

DECEMBER, 1873.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
1 Monday, . . .	30·280	51°	30·222	52°	42°	40°	43°	45°	58	51°	S. W.	1	·000	Fine, breezy, bright sunshine.
2 Tuesday, . . .	30·400	52	30·337	53	50	48	46	47	54	52	S. W.	1	. .	Cloudy, mild, occasional sunshine.
3 Wednesday, . .	30·428	47	30·381	48	42	40	44	46	50	49	S. W.	2	. .	Do.
4 Thursday, . .	30·428	48	30·376	48	42	40	44	46	49	48	S. W.	0	. .	Breezy, cloudy, changeable.
5 Friday, ...	30.280	49	30·228	50	46	44	44	46	51	49	S. W.	0	. .	Do.
6 Saturday, . . .	30·400	40	30·369	44	38	32	43	45	46	45	N. W.	3	. .	Cloudy, mild, occasional sunshine.
7 Sunday, . . .	30·350	47	30·303	48	40	39	43	45	49	48	S. W.	0	. .	Breezy, cloudy, changeable.
8 Monday, . . .	30·392	47	30·345	48	45	43	43	45	49	48	S. W.	0	. .	Do.
9 Tuesday, . .	30·426	47	30·373	47	46	44	43	45	49	48	S. W.	0	. .	Do.
10 Wednesday, . .	30·426	36	30·400	39	31	29	41	44	41	40	E.	2	. .	Cloudy, occasional sunshine.
11 Thursday, . .	30·470	32	30·461	36	26	24	37	40	39	38	N. W.	2	. .	Cloudy, occasional sun, sharp frost.
12 Friday, ...	30·470	34	34·455	38	26	24	35	38	40	39	S. W.	1	. .	Do.
13 Saturday, . . .	30·500	42	30·463	43	38	36	38	39	44	43	S. W.	0	. .	Cloudy, mild, changeable.
14 Sunday, . . .	30·272	41	30·241	43	38	36	38	40	45	44	S. W.	0	. .	Breezy, cloudy, changeable.
15 Monday, . . .	29·950	47	29·904	48	48	41	40	42	49	47	S. W.	0	. .	Do.
16 Tuesday, . . .	29·900	50	29·843	51	47	45	48	44	52	50	S. W.	2	040	Breezy, light showers, bright sun.
17 Wednesday, . .	30·090	52	30·027	53	46	44	44	45	54	52	S. W.	0	. .	Breezy, cloudy, changeable.
18 Thursday, . .	30·100	46	30·053	47	44	42	44	45	48	47	S. W.	1	·050	Cloudy, showery, occasional sun.
19 Friday, ...	29·986	44	29·845	45	40	36	43	44	46	45	S. W.	0	·330	Cloudy, wet, changeable.
20 Saturday, . . .	29·812	43	29·776	45	41	38	41	43	47	46	S. W.	1	·000	Breezy, cloudy, occasional sun.
21 Sunday, . . .	29·900	50	29·909	51	45	43	43	45	52	50	S. W.	0	. .	Breezy, cloudy, changeable.
22 Monday, . . .	29·920	41	29·959	43	39	37	41	43	45	44	S. W.	2	·100	Breezy, showery, occasional sun.
23 Tuesday, . . .	29·920	47	29·948	48	40	38	41	43	50	48	S. W.	0	. .	Breezy, cloudy, changeable.
24 Wednesday, . .	30·200	43	30·232	44	40	38	41	43	45	44	S. W.	0	. .	Do.
25 Thursday, . .	30·050	49	30·064	51	43	41	43	45	52	50	S. W.	0	. .	Do.
26 Friday, ...	29·912	49	29·926	50	45	43	43	45	51	50	S. W.	0	. .	Do.
27 Saturday, . . .	29·814	35	29·867	37	31	30	39	42	38	37	N. W.	1	·050	Breezy, showery, occasional sun.
28 Sunday, . . .	30·028	29	30·096	31	27	25	36	37	32	32	S. W.	0	·000	Cloudy, sharp frost.
29 Monday, . . .	29·618	44	29·645	45	31	30	37	39	46	44	S. E.	1	·000	Breezy, cloudy, changeable.
30 Tuesday, . . .	29·420	46	29·441	47	44	42	40	41	48	47	S. W.	0	·040	Breezy, light showers.
31 Wednesday, . .	29·360	44	29·388	45	40	38	40	42	46	44	S. W.	2	·060	Breezy, occasional showers, and sun.
												22	·670	inches.

nurs

L

ECTI

Nº

S

V E

ne M

No. XLIII.—Vol. VI.] [Price 2s.

THE JOURNAL

OF THE

ROYAL DUBLIN SOCIETY.

CONTENTS:

		PAGE
1.	Dr. M'Nab on Calamites, and their Relations to Equisetums or "Horsetails,"	471
2.	H. Grubb on Clocks for Equatorial Telescopes,	474
3.	Dr. Purser on the Production of Musical Sounds by the Human Voice,	483
4.	Mr. Mac Donnell on the Theory of Heat, and its Applications to Arts and Manufactures,	494
5.	Mr. Mac Donnell on the Use of Peat in Siemens' Regenerative Gas Furnace,	503
6.	Mr. Hull on Glaciers, Ancient and Modern,	505
7.	Dr. Macalister on Rudimental and Provisional Organs,	509
8.	Dr. M'Nab on Sclerenchyma of Mettenius in Plants,	516
9.	Return of Donations to the Royal Dublin Society,	519
10.	Intelligence,	525
	Appendix—Meteorological Journal from 1st January, 1874, to 31st July, 1874,	i

DUBLIN:

HODGES, FOSTER, AND CO., 104, GRAFTON-STREET,

BOOKSELLERS TO THE ROYAL DUBLIN SOCIETY.

LONDON: SIMPKIN, MARSHALL, AND CO. EDINBURGH: JOHN MENZIES AND CO.

1875

The Society

Royal Dublin Society.

FOUNDED 1731. INCORPORATED 1749.

The Society consists of Members, who, on being proposed and seconded, are elected at the next Meeting by Ballot, previously to which the Fees, as follows, must be lodged with the Treasurer:—

Life Membership, ...	£21	0	0
Annual Membership (with £3 3s. Entrance Fee),	2	2	0

Annual Subscriptions due on 1st January. Persons in arrear on the 1st April cease to be Members.

Annual Members may at any time become Life Members upon payment of £15 15s., £10 10s., or £5 5s., according to standing.

I.—Meetings of the Society and the Council.

1. *Stated and Ordinary Meetings.*

The Society meets at 3 o'Clock P. M., pursuant to the Charter, on the second Thursday in November, and the First Thursday in March and June.

The Council meets during the Session at Three o'Clock on every Thursday not occupied by the Meetings of the Society.

2. *Evening Scientific Meetings.*

Meetings of the Society, for the reading and discussion of Papers on Scientific subjects, are held on the third Monday in each Month during the Session.

Persons desirous to read Communications must submit their Papers to the Committee a week, at least, previously, for examination and approval.

The Copyright of all Papers read becomes the property of the Society; and such as are considered suitable for the purpose will be published in the Journal of the Society.

Except under special circumstances, no person can be permitted to occupy the Meeting in reading a Paper for a longer period than half-an-hour; and the Society will not be held responsible for any opinions advocated in the communications read.

Each Subscriber of 5s. to the Refreshment Fund is entitled to Tickets, to admit Visitors. at 6*d*. each; or to twelve for 5s., available for any of the ordinary Meetings throughout the Session.

The Standing Committees.

Six Standing Committees are annually elected, as follows:—1. Agriculture; 2. Botany; 3. Fine Arts; 4. Library; 5. Natural History; 6. Practical Science.

[*For continuation, see page 3 of Cover.*

THE JOURNAL

OF THE

ROYAL DUBLIN SOCIETY.

XXXIII.—*On Calamites, and their Relation to Equisetums, or "Horsetails" of the present day, being the Substance of a Discourse delivered on Monday Evening, February 17th*, 1873. By William R. M'Nab, M.D., Professor of Botany, Royal College of Science, Ireland.

The Equisetums are a group of flowerless plants, familiarly known by the name of horse-tails, water-pipes, or paddock-pipes. They have a creeping underground stem, bearing erect aerial stalks, which are jointed either with or without branches, and having numerous toothed sheaths which are the true leaves. The fruit is cone-like, placed at the end of the ordinary stem, or occasionally produced by a special stem, which differs in appearance and colour from the other. Equisetums live chiefly in moist places, woods, or sides of roads, or on sandy sea-shores.

The nearest allies of the horse-tails are the ferns. Both belong to the great group of the vascular cryptogams, which include, besides the ferns and horse-tails, the ophioglossums, rhizocarps, and lycopods.

The author next proceeded briefly to describe the general characters of the five classes of vascular cryptogams, and then described in detail the structure and life history of equisetum.

STRUCTURE OF EQUISETUM.

The Equisetums produce perennial underground creeping stems, from one or two lines to half an inch in diameter, which run in wet places at a depth of from two to four feet from the surface, and may, under favourable circumstances, spread over a space varying from ten to fifty feet across. The underground stem sends up every year a series of erect branches. These aerial branches are generally annual, rarely lasting longer, and of small size; the largest British species, E. maximum, producing a stem four to five feet in height, and about half an

inch thick. Some of the species produce whorls of small branches, each branch arising from a single cell, which forms in the interior of the tissue at the base of the sheath. This mode of production of branches is peculiar to the equisetums, and is known as the endogenous mode of branching. On making a longitudinal section of a young stem, the minute endogenous branches are well seen. When fully formed, the buds break through the tissues of the base of the sheaths. The buds often remain dormant, but as many should be formed as there are teeth to the sheaths. Similar buds are formed on the underground stem, but many of them remain dormant, the others produce the erect aerial stems. The roots are produced in verticils, one forming under each bud; but they are rarely all developed. In structure the roots of the equisetums resemble those of ferns, and they branch in the same monopodial (racemose) manner.

The young plants arise from a prothallus. Two kinds of prothallus are produced; a small one bearing the antheridia, and a large one bearing the archegonia. From the fertilized central cell of the archegonium the embryo plant is developed. The first leaf-bearing branch consists of from ten to fifteen internodes, the sheath leaves having only three teeth. A second and stronger branch is next formed at the base of the first, the sheath having now four teeth. Others follow, each succeeding one being larger and stronger than the preceding, and having more teeth on the sheath-leaves. This goes on until the parts assume their maximum size. One peculiarity to observe is, that the embryonic parts never enlarge.

The stem consists of a series of hollow internodes with transverse diaphragms, the base of each internode being surrounded by the sheath-leaves of the one beneath. The surface of each internode presents a series of ridges and furrows, which alternate in succeeding internodes. The fibro-vascular bundles in the stem are in the same radii as the ridges. The bundles form a hollow cylindrical net, each bundle containing an air space. Air spaces or lacunæ also exist in the central portion of the stem, and they alternate with the bundles; hence they lie in the same radii as the furrows on the stem. The points of the sheath-leaves also correspond with the ridges, while the endogenous buds are produced at the base of the sheath leaves between the fibro-vascular bundles.

The cone-like fruit of equisetum consists of a series of modified leaves. First there is a modified sheath called the ring, and next a series of whorls of modified leaves, forming hexagonal shields with a narrow stalk. Each shield bears on the inner side from five to ten spore-cases, which contain the spores, furnished with the peculiar elaters.

When a section of the stem is viewed with a low magnifying power, the central air space surrounded by the separate fibro-vascular bundles, and the remains of the pith will be seen. The air-space or lacuna of each bundle will also be distinctly visible. The sheath of the fibro-vascular bundles will also be noticed, either surrounding each bundle separately, or more commonly forming a sheath surrounding all the

bundles and separating them from the cortical tissues. The cortical tissues are chiefly parenchymatous, with large lacunæ. Bundles of thick-walled elongated prosenchymatous cells also occur either as a continuous layer, or only at the ridges, forming the sclerenchyma of Mettenius. The epidermis will be seen externally with the stomata in the furrows, the stomata communicating directly with the lacunæ, and green chlorophyll bearing cells surrounding them. The cells of the epidermis contain quantities of silica in their walls, hence the use of certain species (Dutch rushes) for polishing.

The lacunæ exist both in the aerial and underground stems. Their use is evident. The plants grow in wet, frequently stiff and clayey soil, which contains very little air. Oxygen is essential for the metamorphosis of the assimilated materials stored up in the underground portions of the plant, and it is by means of the lacunæ that the oxygen is conveyed. Plants which live in water or in wet places generally have the ligneous portion of the fibro-vascular bundles only very slightly developed, while in many wood is entirely absent. The necessary strength and firmness in equisetum stems is obtained by the development of the fibre-like thickened cells under the epidermis—the sclerenchyma of Mettenius—which cells also probably convey water for transpiration.

When a transverse section of the stem is examined with a higher power, the structure of the fibro-vascular bundle becomes distinctly visible. The woody portion or xylem of Nægeli is occupied by a large lacuna formed by the absorption of thin-walled parenchymatous cells. The remaining tissue of the xylem consists of one or more annular, spiral or reticulated vessels, and a number of elongated parenchymatous cells generally containing starch. The phlœm portion of the bundle consists of three series of cells, viz., bast parenchyma, thin-walled cells containing starch; wide cells with granular contents, the cribriform cells; and lastly, one or two bast fibres.

When the structure of the root is examined, it is found to consist of an epidermis externally, furnished with root-hairs. Below the epidermis several layers of brown-coloured cells occur, the outer being empty, the inner filled with starch. In the centre is the fibro-vascular bundle, consisting of one or more spiral vessels, numerous soft-walled cells, the bast parenchyma, with one or two cribriform cells. The central bundle is separated from the cortical tissues by the sheath of the fibro-vascular bundle.

RELATIONS OF CALAMITES TO EQUISETUM.

The resemblance between the vegetative parts of Equisetums and Calamites is no mere superficial one. In Calamites as in Equisetums there existed a large underground stem, giving off aerial shoots. Grand Eury has described the underground stem as seen by him at St. Etienne. The branching in Calamites seems to have been the same as in Equisetum. The attachment between stem and branch is therefore slight, the tissues not being continuous, as in monopodial or dichotomous branching.

There seems no reason to suppose that the aerial stems of Calamite were of long duration. Indeed, the presence of the underground stem renders it improbable.

In Calamites as in Equisetums the stem was fistular, and round the cavity the fibro-vascular bundles were arranged, each bundle possessing an air-space or lacuna as in Equisetum. The bundle is apparently prolonged externally, and forms a wedge-shaped mass, the masses often uniting and forming a continuous layer. The cells have a more or less radiating arrangement, some of the cells being large, others small. Here in nearly all Calamites the structure ends. Comparing Calamites with Equisetum, we find that the cortical lacunæ are wanting, the rest of the stem corresponding very closely. The cone-like fruits of Calamites, if they have been correctly identified, agree well with Equisetum, except that instead of all the leaves bearing sporangia, only every alternate whorl is fertile.

The chief difficulty in satisfactorily comparing the stems of Equisetums and Calamites lies in the structure of the fibro-vascular bundles. In Equisetums the lacunæ of the bundle lies between the wood and bast portions of the bundle, and shows tolerably accurately the boundary between them. In Calamites, however, most of the tissue of the bundle, or woody wedge, as Professor Williamson calls it, lies external to the lacuna. I believe, however, that we have to deal with a compound structure. In a South American Equisetum I have observed a peculiar series of elongated hard cells, belonging to the cortical tissues, which pass in and apparently join with the tissues of the bundle. These cells are the sclerenchyma of Mettenius, and are very common in vascular cryptogams. It seems probable that Professor Williamson, of Manchester, has mistaken this group of sclerenchymatous cells for wood cells, and thus wrongly attributes to them the exogenous growth which he describes in Calamites and other cone plants. It is further necessary to be careful in identifying the Calamite stem, used for making sections for the microscope, as I believe that the so-called *Calamites nodosus* is not *Equisetaceous* but *Gnetaceous*. The conical ends of the branches showing that the embryonic parts do not enlarge, is also much against the theory of exogenous growth.

XXXIV.—*On Clocks for Equatorial Telescopes.* By Howard Grubb, C. E.

[Read Monday Evening, November 17, 1873.]

Not having expected to be called on for this paper before the January Meeting of the Royal Dublin Society, and not having some matters I was preparing for illustrating it ready, I shall be obliged to divide my paper into two parts, and purpose, with your permission, to read the second part in the form of a short appendix, at a future meeting.

The problem of obtaining a form of clock for driving Equatorial Telescopes in their motion, following celestial objects, of what may be called mechanical perfection, is one that has long been the study of opticians, and it is only within the last few months that the feasibility of bringing this piece of apparatus to the desired standard of excellence has been apparent to me. Before describing any of the numerous attempts that have been made to the present time in this direction, it would, perhaps, be well that I should describe what the special requirements of an Equatorial clock are, and in what particulars it differs from ordinary pieces of clockwork. The first essential of an Equatorial clock is that its motion shall be a uniform motion. Now, it is hardly necessary to say that none of the regulators in use for ordinary time-keeping clocks possess this quality—the very principle of all such regulators being that the train of wheel-work is held in check by the regulator, be it pendulum, or balance, or any form of either, and allowed to "*escape*" at certain definite intervals, according to the swing of pendulum or balance.

In the so-called dead beat escapement, the train remains motionless from the time each tooth of "escape" wheel touches pallet, until it is allowed to escape. In the recoil escapement the train performs a slightly retrograde movement. Clocks regulated by pendulums are capable of being brought to extraordinary accuracy, for, according to certain mechanical laws, their vibrations must be constant in period, unless affected by certain adventitious sources of error, whose effect upon the clock it is the duty and aim of the clockmaker to reduce, and if possible, altogether destroy.

No doubt, a form of clock could be devised (though I doubt if it has ever been tried, so manifest would be its weak points) in which the intermittent motion of an ordinary clock train would be translated into a uniform motion, but as we proceed its impracticability will be apparent.

The next essential of an Equatorial clock (and here also it differs widely from an ordinary time-keeping arrangement) is that it shall have sufficient power, in actual foot pounds, to drive not only its own works, but also the whole Equatorial telescope to which it is applied. An ordinary house clock has a weight of some 14 pounds, descending about four feet in a week, or = to about one third foot pounds an hour. Eqatorial clocks differ in this respect, according to what they have to drive. In the case of the great Melbourne telescope (an extreme case certainly, and one in which the mass to be moved exceeded nine tons), the driving power of the clock was, I think, about 2,500 foot pounds per hour, and small-sized Equatorials, say five or six in refractors, will generally have about 200 foot pounds an hour.

No doubt, a much less driving power would generally serve to drive Equatorials than is applied, but it is found very desirable to apply a large overplus of power, in order that the clock may not only be equal to driving the telescope in its best condition as regards balance, friction, &c., but also that slight variations of weights of eye-pieces, micrometers, &c., producing want of balance and any increase

of friction due to various causes, may not "tell" on the working of clocks.

In time-keeping clocks, the clockmakers are so fully aware that any difference of force applied to the pendulum will alter its arc and period of vibration, that numerous improvements have been made from time to time to render this force as constant as possible.

The variations of the work to be done by a time-keeping clock are of course very much less than those of an Equatorial clock, being principally confined to variations of friction, and (in the case of public clocks) the effect of wind on the hands; and the introduction of what is known as the remontoire train renders the pressure on the pallets, and consequently the beat of pendulum, practically constant. It will be evident from the foregoing that any attempt to regulate a train of wheelwork for driving an Equatorial by a pendulum directly would be quite impracticable, and I shall now proceed to describe various appliances to obtain uniform motion, otherwise than by the direct influence of a pendulum. I say "direct" influence, for, as will be afterwards seen, the pendulum is indirectly used in some cases as an auxiliary control.

The various forms of rotary governors that I propose to consider, and in which I think may be included all recognised regulators, are,

1st. The Fly wheel.

2nd. The Fan.

3rd. The Frictional governor.

4th. Various combinations of 1, 2, and 3.

5th. Various attempts to associate the action of a pendulum with either of Nos. 1, 2, or 3.

1st. The Flywheel is probably the least effective of all forms of regulators for obtaining accurate rotary motion; a very slight variation in the power applied to, or the work to be done by, a machine regulated by a flywheel, causes a very large alteration in rate; at same time, however, the flywheel has by its *vis inertiæ*, or work stored up in it, a great facility for smoothing over small obstacles, and thus giving a smooth though not very uniform motion. It is well, therefore, in whatever other form of governor is used, to have some "flywheel power," as it were, or in other words to have some portion of the train so constructed that it shall have considerable *vis inertiæ*; but in itself a fly can hardly be considered as a regulator at all.

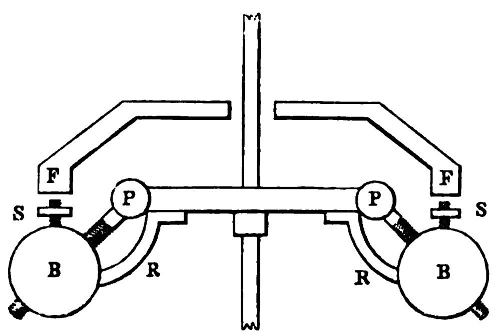
2nd. The Fan. This form of regulator has not that quality of smoothing over small inequalities that the flywheel possesses, but it has much more power of keeping clock to a definite rate, inasmuch as the resistance of the air increases very largely with increase of speed. By enclosing the fan also in a box with "Louvres" capable of being opened and shut, a convenient mode of rating is obtained as the closer the "Louvres" are placed, the more air will be carried round with the fan, and thus the resistance will be decreased. Neither the fly nor the fan, however, are worth much consideration, when we have so convenient and effective a regulator in the—

3rd. Frictional Governor. Every one knows the ordinary steam-engine governor, and how the balls fly out as the speed increases, and fall together as it diminishes, always assuming such a position that a line drawn through the points of suspension and centre of gravity of the balls forms a resultant to the two forces acting upon it at that moment, viz., gravity and centrifugal force.

In the case of the steam-engine governor, the fact of the balls receding from one another as the speed of centrifugal force increases, causes the throttle or supply valve to be partially closed, and so within moderate limits the speed of the engine is kept sufficiently constant.

Now in the case of Equatorial clocks we have no throttle valve to shut off, so, instead of cutting off the supply of power, we endeavour to use it up in a way otherwise than that of increasing the clock's speed, viz., by increased friction.

The accompanying diagram will explain the action of the frictional governor.



The balls B, pivoted at P, and free to move in a vertical plane, lie when not rotating on the pieces R. As soon, however, as machine is started, and just before it attains its correct speed, the centrifugal force becomes sufficient to raise them off R, and the leather-pointed screws S, rub as they rotate against the carefully trued gun-metal ring or friction plate F.

In the normal condition of affairs, and the clock at its correct speed, the leather-capped screws should just rub lightly or friction plate, but never lose contact, while if some slight acceleration occur instantly the pressure and consequent friction between screws and friction plate increases.

The large amount of perfection obtained in these frictional governors is probably due to the promptness of the governing action. If an acceleration occurs, the whole movement necessary for correcting that acceleration is merely the amount the leather top can be compressed by the additional centrifugal force, an infinitesimal quantity.

Before passing from the frictional governor, I shall mention a few matters of detail necessary for its best performance, the neglect of which, in some cases, brought this form rather into disrepute some years ago.

Many of the original governors of this class were made of such proportions that when the clock rotated at its normal rate, the balls still lay on their supports, and the friction screws did not bear on the friction plate at all, and it was only when the clock went too fast that the balls arose, and by the friction of the screw against plate checked the speed. This is evidently bad, and causes a jerking undulatory motion. The friction screws should always be well in contact, and the effects of a deviation from the normal rate of clock should be merely that of a difference of pressure, and consequent friction, between screws and friction plate.

The proper suspension of the governor balls is a very important point, and one rarely attended to.

It is a common practice to suspend the balls from centres very nearly coinciding with axis of rotation of governor spindle. In the diagram, which is drawn about to that proportion found to be best by experience, it will be seen that the position of the centres of suspension is very different to this.

It has been proposed, and indeed carried out in some instances (though with no advantageous result, as far as I am aware) to suspend the governor balls, not on centre screws, as I have shown in fig. 1,) but on pieces of clock spring, the idea being of course to get rid of the friction of the centre screws; but as the working of these levers that carry the balls on their centre screws does not exceed probably $\frac{1}{1000}$ part of a revolution (during action), being 'in fact the amount that the leather caps are compressed by the difference of the pressures due to the different rates, I think this may well be neglected, and there seems a very strong objection to the use of the spring suspension; for while the clock train urges the ball forward in one direction, friction against the plate is exerting a force in the opposite direction, and consequently there is a tendency to twist the ball on its support. We therefore take the precaution of making the distance between the bearings of this lever which carries the balls, as great as possible, to give it great stiffness and strength in this direction; but the spring suspension could have no strength at all to resist this, and consequently the motion would be unpleasant and fitful.

It has been proposed to use three balls, placed at 120° apart, instead of two at 180°—I suppose for the following reason.

In a conical pendulum, as this is, the balls move, not necessarily in a circle, but an ellipse approaching more or less nearly to a circle, and if the two balls happen to synchronise as to the direction of the axis of the ellipses, the result would be not a uniform, but a slightly undulatory motion. If three balls be used, it is supposed by some that the danger of this is removed. However, this objection applies particularly to that form of governor in which the working angle is over 45°. If the

directions as above are attended to, the three balls are not advantageous—I would indeed prefer to put the extra 50% of weight into the two original balls.

Again, good results have undoubtedly been obtained with only one ball, but I cannot see any possibility of advantage over two.

The principle of Porter's steam engine governor has been proposed for application to equatorial clocks, but I do not think any advantage would be obtained.

In Porter's governor the balls are small and light; but, before they can rise, they must lift a considerable weight (the action of gravity being thereby intensified as it were), and consequently the governor has to be driven at a considerably greater rate.

The effect is, that the action of the balls is what is technically called more "lively," and they act more promptly in shutting and opening the throttle valve; but in the case of the frictional governor the angular movement of the balls (due to increased rate) is infinitesimally small, so that any advantage from adopting Porter's principle would be infinitesimally small also, in fact, practically nil.

My experience has led me to believe that a frictional governor properly constructed will act as well as any other form of rotary regulator contrived until the invention by Mr. Gill of the control system, which I shall describe just now.

4th. Various combinations of above forms have been tried, such as Fan and Frictional governor, a governor acting on louvres of a Fan, &c., &c., with more or less success.

5th. Various attempts to combine or couple an intermittent motion train governed by a pendulum with a uniform motion train, and govern the latter by the former.

The most elementary idea of this form I have heard of was attached, I believe, to a small clock in an Equatorial in the Paris Observatory. In this clock, as explained to me, there were two separate trains of wheelwork, one for the uniform motion, and one for the intermittent or pendulum train; two spindles, one driven from the uniform, and one from the intermittent train, and moving normally at equal rates, are coupled together by some form of spring coupling; the idea being that the spring would allow just so much "play" as would accommodate for the temporary difference between the uniform and intermittent trains; but if one ran on at all or lagged behind the other the spring would tend to keep them together.

I have not been able to obtain any data as to the working of this clock, but I should be surprised if it performed as well even as a good frictional governor; for, judging from various experiments made in this direction, I believe the uniform motive train will be much more likely to govern the intermittent train than to be governed by it; and it is evident that, whenever any inaccuracy occurs, the pressure on pallets varies, and consequently the swing and rate of pendulum.

Bond's Governor is of this form, but very carefully carried out as to mechanical details, and good accounts have been given of its per-

formance; still, however, for the reasons given above, it seems impossible that its action can be perfect. Some two years ago, I contemplated a clock of this kind, and, indeed, had one partly made, but laid aside from press of work. In this clock (being fully alive to the objections above mentioned), I had two pendulums; one was to be a perfectly free pendulum driven by an independent weight, and no work to do but make electric contacts; the second pendulum, which was that which governed the clock, was driven by the first by a very powerful current, the idea here being of course to get a pendulum that would not be so easily re-acted upon by the uniform train. I have no doubt this would have performed well, but not so well as what has been devised since.

An ingenious combination of the pendulum and fan has been adopted by the Messrs. Cooke of York, in some of their equatorials. In their clock a pendulum is driven by a remontoire train from uniform motion train, which uniform train also derives a fan in a box with "Louvres." The arm of the remontoire is attached to a lever acting on Louvres of fan box. If the uniform train of clock keep exactly at normal speed, the remontoire arm vibrates a small constant quantity, and sufficient "play" is allowed in the connexions of the arms to prevent this acting on the Louvres; but if the uniform train goes a little fast, the remontoire arm drops through a larger arc, and slightly opens the Louvres, and thus checks speed, and *vice versâ*.

This arrangement is very ingenious, and keeps clock to a very good rate; but it is evident on consideration, that when an error occurs, although this arrangement tends to bring rate again correct, it will not correct the error that has occurred, and thus the clock will be brought to its normal rate, with however the telescope in a different position to that it originally eccupied.

I have now to describe the only clock I have met with which seems to me to be capable of being made mechanically perfect in its action.

This clock is the invention of Mr. David Gill, director of Lord Lindsay's observatory, whose lecture here some months ago on control clocks is still remembered with much pleasure by many of us.

The first of these clocks has been applied to the Great Equatorial of the Dun Echt observatory, which we have recently erected for Lord Lindsay, and its performance gives good promise of perfect success.

The foundation (so to speak) of the clock is a good frictional governor, Mr. Gill having strictly adhered to the points mentioned above.

A system of checks, electrically worked and regulated by an independent pendulum, are applied to this governor every second, so that no error is allowed to accumulate for more than one second; and it is easy to show that, if the clock be properly constructed, the greatest error at any time should be but $\frac{1}{120}$ of a second, provided the cause of error be not so great as to be beyond the reach of the control.

The mode of applying the checks is as follows:—

Two light rods capped with leather at lower end, and provided with cups to hold shot for regulation of control at upper end, hang over a

disc, which revolves with governor spindle. These rods are capable of being raised and lowered by a pair of electro-magnets, so that they are either one or both rubbing on disc and producing friction, or raised entirely from it. The clock is so rated that in its normal state its rate will be correct with one rod in action, fast if both be raised, and slow if both in action. Now let us see how these electro-magnets are acted upon according to whether the clock be fast, slow, or right.

A seconds pendulum, quite independent of clock, is made to beat seconds accurately being controlled from normal sidereal clock of observatory. This pendulum makes an instantaneous contact once a second, and sends a current through a wire to the clock, when, as shall be presently explained, it is distributed according to whether the clock is fast, slow, or right, into either of three electro-magnets which work on electric switch into either of three positions, right, left, or intermediate.

Let us suppose the clock for a short interval to go exactly right, in which case one of the two friction pins above-mentioned will be in constant action. Now if the clock go fast, the switch is thrown to the right, and a current is sent through the electro-magnet that will allow the second friction pin to drop into action ; if slow, it is thrown to left, and a current is sent through other electro magnet, and both friction pins are for the instant raised out of action.

It now remains to show how the current is distributed according to whether the clock is fast, slow, or right. This is very ingenious. On a second spindle of clock is an insulated wheel bound with a band of silver round edge.

This silver is not continuous, but it is divided into three parts, two parts extending, each over about 178° of circumference and the third part being a mere pin extending but about 3° or 1·120th of circumference. A silver contact spring rubs on this wheel as it revolves, and is connected to one pole of a battery at instant pendulum makes contact, and each of the three silver pieces being connected to the coils of each of the three electric magnets of switch, a current is sent through one or other of these magnets according to what part of the circumference is in contact with the spring, at the exact moment that the current is sent by the independent pendulum. Now if the clock be going quite correctly as to rate, the current from pendulum enters clock by spring exactly at the moment that the spring is in contact with the intermediate pin on wheel, in which case the current is sent through that magnet that brings or keeps the switch in its intermediate position, and keeps one friction pin in action; if, however, the clock has gone 1–120 parts fast, the current is sent into one of the two lateral magnets that draw switch to one side and drops the second friction pin ; if slow, the current being sent into the other magnet, the switch is drawn to other side, and both pins are raised, and so on until clock again attains its normal speed, when the one pin is kept in action till some new disturbing force arises.

As the space between the intermediate pin and each of the side silver pins is but 3° or 1·120 of circumference it is easy to show that if

any error over 1-120 occurs, it is instantly checked by this elegant system.

I have no doubt whatsoever that this clock is perfectly correct in principle, and will work as near perfection as possible, and there is but one improvement (if, indeed, it can be called an improvement) which I could suggest. In such an observatory as Lord Lindsay's the addition of a few batteries, and the additional trouble involved thereby, is of course not worth speaking; but few observatories are on such a scale, and it seems to me that if it were possible to carry out this check system mechanically instead of electrically worked, it would be more likely to be generally adopted. I believe this can be done, and I had hoped to show some experiments illustrative of this: however I shall be obliged to defer these for a future occasion; but I may here shortly state the principle on which I purpose to construct this control mechanically.

A seconds pendulum will be driven from the uniform motion clock by the interposition of a remontoire train; that seconds pendulum or its escape wheel will raise and drop a small weight once a second; should the weight necessary be found to be such as to interfere with the perfect working of the pendulum, it can be raised altogether by the uniform train, and merely dropped by the action of the pendulum. This little hammer will strike on a moving wheel or arc connected to uniform train, and according to the position the wheel or arc is struck in; one, two, or no friction pins will be allowed to act against a revolving disc.

It will be perceived that in this, as in Mr. Gill's, the principle aimed at is this, that no matter how the uniform motion train gains, whether it goes fast, slow, or right, that neither in the power supplied for driving, nor in the regulating power taken from the pendulum, can any variation whatsoever occur.

In Mr. Gill's case, the acting power of pendulum is an electric current sent once a second from normal clock, and the regulating power is merely that of making an electric contact. In the mechanical control last mentioned, the power supplied is through a remontoire train, and the regulating power is obtained by the intermittent train raising a constant weight through a constant space. In all these cases the driving power supplied to, and the regulating power taken from pendulum is absolutely constant. This combined with the promptness of its action, renders this system, whether electrically or mechanically worked, the most perfect, as far as I am aware, of anything hitherto attempted.

XXXV.—*On the Production of Musical Sounds by the Human Voice, being a Discourse delivered on December 15th*, 1873. By Dr. Purser.

At the top of the trachea or windpipe, and below the root of the tongue, lies the larynx or organ of voice. Before proceeding to the consideration of the sounds produced by this organ it is necessary to gain some knowledge of its structure. The following anatomical description is confined to merely such an account as will make the action of the larynx as a musical instrument intelligible.

The larynx consists of a skeleton or framework, the various elements of which are united to one another by joints, which allow of movement between the parts in certain directions. The skeleton is formed not of bone but of cartilage, a substance possessing not only sufficient firmness and rigidity, but also considerable flexibility and elasticity. The windpipe is kept permanently open by rings of cartilage, and to the top of the windpipe is firmly attached the first piece of the larynx. This, too, is a ring, but much stronger than the rings of the trachea. It is not a flat ring like a quoit, but a deep ring like a piece cut off a tube. Its depth is not everywhere the same, but much greater behind than in front; so, while its lower edge is horizontal, its upper edge is cut very obliquely from above downwards and forwards. This ring is the fixed point of the larynx; to it are articulated the other parts of the laryngeal skeleton, and on it they move. It is called the *cricoid cartilage*.

The next portion of the skeleton is called the *thyroid cartilage*. It consists of two symmetrical pieces, each somewhat square in shape, and which meet in front, as the bows of a ship meet in the cut-water, forming a prominent vertical ridge, which can be easily felt in the neck, and which is commonly known as the *pomum Adami*, or Adam's apple. The posterior edges of the pieces (*alæ* or wings) of the thyroid cartilage are widely separated from each other; and between the wings, or in the angle formed by them, lie the remaining portions of the larynx. The posterior superior and the posterior inferior angle of each ala are prolonged upwards and downwards respectively. The superior angles are attached by cords to the tongue bone, from which the whole larynx is suspended, while the inferior angles embrace the cricoid cartilage, and are articulated to its outer surface posterior to its transverse axis. This joint admits of but one kind of motion, namely, rotation of the thyroid on the cricoid in a vertical plane, through a limited arc. Owing to the obliquity of the superior edge of the cricoid cartilage, there is a considerable interval between it and the thyroid anteriorly; this interval is filled up by membrane; it can be readily felt in the neck, and it is diminished by rotation downwards of the thyroid cartilage.

The next portion of the laryngeal skeleton consists of two pieces, each of which is the shape of a triangular pyramid. They are seated, one at each side of the middle line, on the posterior part of the upper edge of the cricoid cartilage. To the upper part of these pyramids are attached structures which do not perform any essential part in the production of voice. This part may consequently be neglected, and we may consider each pyramid, reduced to its base, as a flat triangular piece, having one sharp, long angle directed forwards, another outwards, and a third, more blunt, directed inwards. Each cartilage enjoys the power of rotation in a horizontal plane, around its internal angle. By this rotation the long anterior angles can be approximated or made to recede from each other. The other portions of the framework of the larynx do not require description for the present purpose.

The cavity of the larynx is divided into an upper and a lower portion, by a horizontal membranous septum; this septum does not extend completely across the laryngeal tube, but consists of two lateral portions, like side curtains, which leave between them a space, called the *glottis*. These curtains are attached on each side to the inner edge of the thyroid cartilage, and to the antero outer edge of the arytenoid cartilage. Their free internal margins pass from the angle of the thyroid in front, backwards, and outwards to the projecting anterior angle of the arytenoid posteriorly. The free edges are formed of an elastic fibrous tissue, and are called the *vocal cords;* the outer part of the membrane is formed chiefly of muscular tissue. The vocal cords consequently are not cords like the strings of a harp or of a piano, but only the sharp free edges of the membrane, which has been described, and the boundaries of the glottis or the interval between them. The glottis is a very important opening, for not only is it at this point that voice is produced, but through this narrow fissure all the air passes to and from our lungs; and if any obstruction were offered to this passage we should be dead in a few seconds; hence this chink may be looked on as the very gateway of our life. The effects produced on this opening by the movements of the framework of the larynx are, reduced to their simplest expression, the following:—Depression of the anterior part of the thyroid cartilage separates the anterior attachment of the vocal cords from the posterior, and consequently makes tense the vocal cords. Rotation of the arytenoid cartilages (the two cartilages always move together), alters the shape of the glottis. When the larynx is at rest this is triangular—the apex in front at the thyroid attachment of the vocal cords, the sides formed by the vocal cords and by the internal edges of the arytenoid cartilages, and the base, posteriorly, formed by the small part of the edge of the cricoid which intervenes between the two arytenoid cartilages. When the latter cartilages are rotated, so as to divaricate their anterior angles, the glottis becomes diamond-shaped, the sides of the anterior angle being formed by the vocal cords, of the posterior angle by the inner edges of the arytenoid cartilages. When the rotation is in the opposite direction, the anterior angles of

the arytenoids are brought together, while at the same time the whole cartilages slide on the cricoid so as to close up the interval between them; by these means the vocal cords lie in their whole length close together, and the glottis is changed into a linear slit.

In order to effect these changes in the tension and position of the vocal cords, the larynx is abundantly supplied with muscles which move the different parts of the skeleton on each other; there are also muscles running from the larynx upwards and downwards by which the whole organ can be raised and depressed. [The anatomical details and movements of the larynx were illustrated by diagrams and by a model which showed how the tension of the vocal cords and the shape of the glottis could be altered.]

It is of great importance that we should be able to see into the larynx, not only in order to make physiological observations on its movements, but also in order to detect and treat its diseases. The difficulties in the way of seeing the larynx are two-fold:—1st, the larynx is dark; 2nd, it lies round a corner out of our line of sight. Both of these difficulties are overcome by means of the laryngoscope, an instrument which consists: 1st, of a concave mirror by which a strong light is thrown into the back of the mouth; 2nd, of a small plane mirror, placed on a long stalk at a suitable angle, which receives the light and reflects it down into the larynx so as to illuminate its cavity; the plane mirror also serves to reflect to the eye of the observer the image of the illuminated larynx. The instrument, as it at present stands, is the invention of Professor Czermak. Before he perfected it, very numerous attempts were made to see the larynx, but they were all fruitless of results, with the exception of those of Signor Manuel Garcia, a very eminent teacher of singing, who in 1855 embodied his experiments in a paper laid before the Royal Society. It was with a view of testing and completing the observations of Garcia that Czermak first occupied himself with laryngoscopy. [The laryngoscope, and the auto-laryngoscope, and the modes of using them were shown, and a demonstration given of the concealed model larynx, by means of a mirror held obliquely over it.]

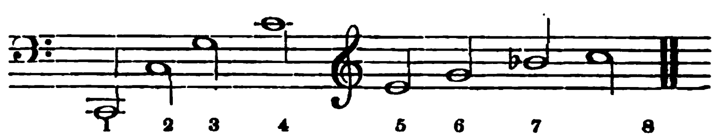
A description was then given of the propagation of a wave of sound from a sonorous body to the ear. Each particle of air moves through only a small space, and returns to its position of rest, having transferred its motion to the next particle, until the vibration reaches the particles of air in the neighbourhood of the ear; these transmit their motion to the drum of the ear and to the auditory nerve, whose disturbance causes in the brain the sensation of sound.

When the sound is a noise the impulses on the ear are of rapidly varying intensity, and follow each other at irregular intervals; but when it is a musical note the impulses follow each other at perfectly equal intervals, the parts of the ear fall into a regular, equable vibration, and a restful feeling is caused instead of the jarring, unpleasant effect of a noise.

Musical sounds differ among themselves in three respects:—1. Intensity or loudness. 2. Pitch, or acuteness. 3. Character, or timbre (*Klangfarbe*).

1. The intensity of a note depends on the amplitude of the vibration of the air-particles through which it is propagated, on the distance through which each of them swings as the wave of motion passes over it; or, in other words, on the velocity with which they move in performing their swing, on the hardness with which they strike against the drum of the ear. The greater the amplitude of the vibration, the more rapid the movement, the louder the sound.

2. The pitch of a note depends, not on the amplitude of the waves, but on the rapidity with which they follow each other, on the number of impulses which strike on the ear in each second. Every series of periodic impulses will not cause in us the impression of a musical note; the ticking of a watch for instance; here the impulses follow each other at too long intervals. There are other cases in which the sound is either inaudible as a musical note or altogether inaudible because the impulses follow each other too rapidly. These limits are imposed by the anatomical structure of the ear, and are very wide, for we can hear sounds which extend through about eleven octaves, or those which correspond to from 16 to 38,000 vibrations per second. The more rapid the vibrations the higher the note, and in the order shown in the accompanying figure. Taking a note and multiplying its vibrations by two we get its octave, by three its twelfth, by four its double octave,



and so on. From this it follows that the ratio of the vibrations of the notes forming a fifth is 2 : 3; a fourth 3 : 4; a major third 4 : 5, &c. [The siren was here exhibited, its structure explained, and it was shown that, as the rapidity of revolution of the perforated disc increased the note emitted rose in pitch.]

3. Two notes may have the same loudness and the same pitch, and yet they may differ very much one from the other; this difference depends on what the French call *timbre*, and the Germans *Klangfarbe*. We have no corresponding word, but every one is familiar with the difference, every one can distinguish between the sounds of a flute, violin, clarionet, the human voice, &c.

Almost every note which is available for musical purposes is produced, not by vibrations of only one period, but by vibrations of several periods; in fact, all these notes are true *chords*, and their composition is quite analogous to that of white light, which, as is well known, is caused by vibrations of all the periods corresponding to the colours of the spectrum. The note which gives its name to the compound sound

is usually the lowest, or that corresponding to the smallest rapidity of vibration; this is called the fundamental note. The other notes are caused by vibrations which stand in rapidity to that of the fundamental, as 2, 3, 4, 5, 6, &c., to 1. These are called the harmonics or overtones of the fundamental note, and, speaking generally, they diminish in intensity as they ascend. It will be noticed that as far as the sixth of this series the notes are those of the common chord, with predominance of the fundamental note; and as far as the eighth they are the notes of the minor or dominant seventh. Some musical sounds, as that of the clarionet, of a stopped organ pipe, &c., have only the notes corresponding to the series of odd numbers; so the first harmonic is not the octave, but the twelfth, the second the third above the double octave, &c. All these compound musical sounds are called by the Germans "klangs," while the sounds produced by vibrations of one period only are called "tones." Of this latter class are the sounds of a tuning fork provided with a resonator, of a large stopped organ pipe, of the voice singing a very pure U; the flute, flageolet, and instruments of that class give a sound poor in over-tones; all these sounds have a spiritless, dull character, and from the absence of the higher tones of the klang, the notes emitted appear lower in pitch than they really are. Most other musical instruments give klangs very rich in harmonics; this is peculiarly true of brass instruments as a class, and of most sounds of the human voice.

It has been proved that the *timbre* of a musical sound depends on the number and relative strength of the harmonics which accompany the fundamental note, and that it is the differences in these which cause the differences in character of the klangs of different instruments.

This has been shown, both by analysis and by synthesis, both by the taking to pieces of the sound, and by the building of it up again. The analysis of a klang is effected by what is called resonance. In most musical instruments the original vibrating body, the prime generator of the sound, is placed in communication either with some extended surface or with an air-containing cavity, which surface, or partially confined mass of air, enters into vibration synchronously with the original vibrator, and by this means the whole vibrating mass is greatly increased, and a much greater amount of motion is communicated to the free air, and the sound consequently gains greatly in intensity. The extended surfaces are called sounding-boards, and these have the power of vibrating in unison with notes of widely different pitch; such is the upper surface of a violin, the sounding-board of a harp, piano, &c. All these strengthen the low notes of the instrument as well as the more acute. The air cavities, which are called "resonators," on the other hand, are less accommodating; each mass of air will, according to its size and shape, vibrate in unison with certain notes, and will strengthen these, but will have no effect on the notes of other periods; and if a compound sound or klang is produced in the neighbourhood of a resonator, this will pick out the element of the klang which cor-

responds to its own period of vibration, and strengthen it, so that it can be heard above all the other tones. (It was here shown how different resonators would answer each only to its own tuning fork, and how when several tuning forks were presented to the different resonators, these in each case selected the fork in union with itself, and strengthened its note only.)

Resonators are made generally of glass or metal, and are provided with an opening by which their cavity communicates with the external air. The air in the resonator, when vibrating, impresses strongly the walls of the cavity. If then we could make the drum of our ear part of the wall of the resonator, the intensifying effect of the latter would be greatly increased. This is accomplished by having another hole in the resonator, opposite to that already mentioned; the hole runs into a short tube which fits accurately into the ear. By this means the cavity of the external ear-passage is made one with that of the resonator, and the drum of the ear is made part of the wall of the resonator, consequently, whenever the air in the latter is thrown into vibration, the effect on the ear is so great as to make the note of this period audible to the exclusion of all others.

The higher the note the smaller the corresponding resonator, so that at last we come to notes to which the external ear-passage itself acts as a resonator. These notes are contained in the topmost octave of the piano, from *e* to *g*. They sound much more intense and harsher than the notes above and below them. Dogs, who howl to music, are said to be very sensitive to the high *e* of the violin.

It will now be readily understood how the analysis of a klang is effected. A series of resonators is provided, and while one ear is stopped, these are applied in succession to the other; those tones which occur in the klang are heard when the resonators corresponding to them are used, while with resonators corresponding to all other tones no effect is perceived. By this means, not only the number of the over-tones but their relative strength is determined.

The synthesis of klangs is effected by an instrument invented by Helmholtz. It consists of a series of tuning forks, with suitable resonators. The forks can be set in vibration in various combinations, and the intensity of the sound of each can be varied by approaching or withdrawing its resonator. By combining the tones in accordance with the results of analysis, the klangs of the different musical instruments can be imitated.

(It was here explained by diagrams, and by means of a silver cord set in vibration by an electro-magnet, how a string could be made to vibrate as a whole or in parts. It was shown on the monochord that when the string was plucked the fundamental note was accompanied by harmonics, due to vibrations of the string in parts, which harmonics could be made to sound alone by touching the string so as to damp the other tones. It was further shown how, according to the point of the string which was plucked, the timbre of the klang produced was different, and how in each case a different set of harmonics was present,

those whose nodal point lay at the part plucked being always absent.)

Coming now to consider more particularly the production of the human voice, we observe the following phenomena in every act of vocalization—first the breath is drawn in, then the anterior angles of the arytenoid cartilages are approximated, the glottis is closed, and the vocal cords lie evenly side by side, then an expiratory effort is made. By this the air in the trachea, below the glottis, is compressed, and when this compression reaches a certain degree the vocal cords yield, so as to allow a puff of air to escape; then they swing back and again close the glottis, again they are forced asunder, another puff escapes, and again the glottis is closed. The vocal cords thus fall into regular vibration, by means of the pressure exerted on them from below and their own elasticity, but the sound is not produced directly by their vibration, as it is by that of the strings of a harp or violin, but indirectly by the successive puffs of air which are allowed to escape between the vibrating edges of the glottis. That this is so is proved by the complete loss of voice which is produced by any circumstance which prevents the vocal chords from coming together evenly so as to close the opening between them. The larynx, consequently, belongs to the class of reed instruments, in which the sound is caused by the cutting up of the stream of air into discontinuous puffs by means of a vibrating valve interposed in its course.

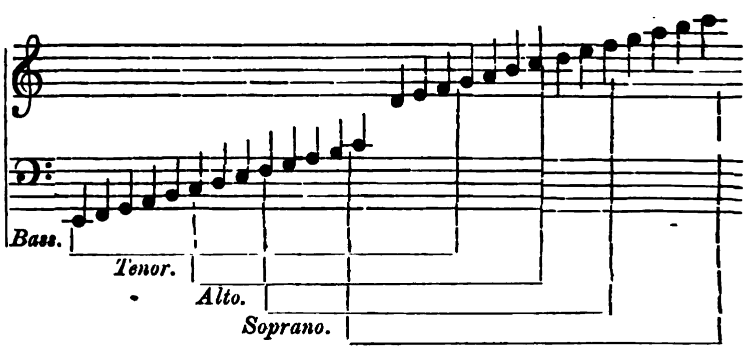
The sounds of the larynx, like those of other musical instruments, present variations in intensity, pitch and timbre.

The loudness of the voice depends chiefly on the strength with which the air below the glottis is compressed. The more forcible this compression the more violent are the puffs of air emitted through the glottis, and the greater the disturbance caused in the surrounding atmosphere.

The pitch of the voice depends on three circumstances. 1. On the length of the vocal cords or the vibrating portion of them. The shorter this is, the higher is the note, other things being equal. J. Müller found that in man the mean length of the vocal cords was, when at rest, $18\frac{1}{3}$ mm.; when tensely stretched, $23\frac{1}{6}$ mm.; in women $12\frac{3}{4}$ and $15\frac{3}{4}$; in children $14\frac{1}{3}$ and $10\frac{1}{4}$. This, to a great extent, accounts for the graver pitch of the voice in men than in women and children. 2. The greater the tension of the vocal cords the higher the pitch. But the more tensely stretched the cords are the greater is their length; hence the same note may be produced by shortening the vibrating part of the cords, maintaining the tension low, or by forcibly stretching them, while they vibrate in their whole length. We shall see when we come to speak of the different registers, that both these methods are employed. 3. The pitch of the voice is raised by increasing the force of expiration, the length and tension of the cords remaining constant. This accounts for the frequency with which persons sing sharp when swelling a long note, and for the equally common fault of singing flat when the breath becomes exhausted. Whenever the force of expiration

then, is increased, it is necessary in order to maintain a constant pitch, to diminish the tension of the vocal cords, and *vice versâ*. The ease and certainty with which this harmony is maintained between the different parts of the vocal apparatus is one of the most wonderful and beautiful subjects of contemplation to be met with in the whole range of physiology.

The compass of the voice, of course, varies greatly according to individual peculiarities. For artistic purposes voices are divided into four classes—bass, tenor, alto, and soprano; the compass of each being about two octaves, and the whole compass from the deepest notes of the bass to the highest of the soprano being about 4 octaves.



The timbre of the voice is quite characteristic, and serves to distinguish it from all other musical instruments; but besides this, the voice differs from other instruments in possessing several distinct *timbres* which differ among each other almost as much as the sound of one orchestra instrument does from that of another.

We cannot make the larynx sound without pronouncing some vowel; we must, as it is said, sing *on* some vowel. Now the character of the voice differs very much according to the vowel sung. The vowel sounds may, consequently, be considered as so many vocal timbres, and the theory of their production will fairly come under consideration here. For the full working out of this theory we are indebted to Helmholtz.

The sound of the larynx is very rich in harmonics; in the strongly sung notes of a bass voice Helmholtz has heard the series extend to the 16th or 20th member, notes which lie in the highest octave on the new pianos. If the larynx were bare, i. e. without the pharynx and mouth, these harmonics would diminish in loudness as they ascend, as is the case in most instruments; but the mouth and pharynx act as a resonating cavity, and, according to their shape and size, select certain notes out of the harmonic series, and strengthen them while the other notes are enfeebled. This strengthening, however, is not of any particu-

lar number of the harmonic series, but always, according to the vowel, of a particular note, whether this be the first, second, third or higher harmonic of the fundamental note given by the larynx; in each case that tone of the klang which is nearest to the proper tone of the mouth is strengthened. But this proper tone differs according to the shape of the mouth. This may be proved by forming the mouth for the production of the different vowels, and bringing to the orifice of the lips a series of vibrating tuning forks. It will be found that for each position of the mouth one fork will have its sound strengthened, and that with the different positions these forks are different. That note of the tuning fork which is strengthened in any given position of the mouth is the note of the klang of the larynx which is predominant, when the voice is made to sound with the mouth in the same position.

This peculiar strengthening by resonance of a particular note, and not of a particular number of the harmonic series, arises from the independence between the vibrating period of the vocal cords, and that of the air in their resonating cavity. In most reed instruments the period of vibration of the reed is determined by the size of the resonating tube, and the different notes of the scale are got by altering the length of the latter, by means of valves, finger-holes, &c.: but in the larynx the period of vibration of the edges of the glottis is regulated by their length, tension, and the force of blowing, and they can vibrate in any period, whatever may be the size and shape of the mouth and pharynx; but this cavity, by strengthening in each case its own proper note, regulates the timbre of the sound, although it leaves its pitch unaffected. These facts explain the circumstance which is familiar to all singers, namely, that the production of the different vowels is not equally easy in all parts of the scale. According to Helmholtz each vowel is most easily sung on those notes which lie a little below the characteristic note of that vowel, and next most easily on such a note that the characteristic note is the second or third harmonic of the note sung.

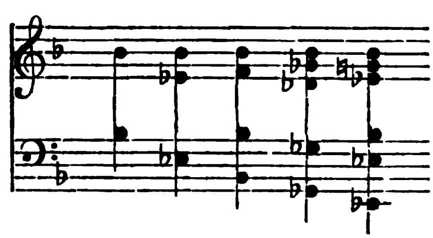
We may now consider the shape of the mouth in the production of the different vowels, and the notes which are strengthened in each case. In the following description the account given by Helmholtz is followed. This applies only to the North German vowels; the characteristic tones corresponding to the English vowels have not been investigated by Helmholtz's method. This writer finds that the characteristic note is the same for each vowel whether pronounced by a man, woman, or child, the differences in the size of the resonating cavity being compensated by differences in its shape; but very slight varieties in the pronunciation of the vowels, as in the different dialects, and still more in different languages, serve to completely alter the characteristic notes.

When A is pronounced the mouth has the shape of an open funnel, the wide end being in front, the narrow end posteriorly just above the larynx. In this position the mouth resonates to B flat, above the first leger line in the treble, and this is the characteristic note of A.

Passing to O, the lips are drawn in so as to form a narrow orifice, while the posterior part of the cavity is enlarged; the whole then resembles a flask with a narrow opening, but without a neck, It then strengthens B flat on the third line of the treblè stave. When U is pronounced the general shape of the mouth is the same, but the orifice is narrower and the cavity more capacious. F on the fourth line of the bass stave is now the characteristic note.

With the other vowels the general shape of the mouth is completely altered, for the tongue, which when A, O, U, were being pronounced, lay on the floor of the mouth, now approaches the palate, and forms with it a narrow channel, opening behind into a dilated space above the larynx. The form of the whole is now that of a bottle with a long neck, and it strengthens two notes, one, the higher, corresponding to the tubular passage between the tongue and palate, the other, more grave, to the posterior pharyngeal cavity. The larger the cavity, the longer and wider the tube, the lower are their respective tones. The actual notes are given in the table.

The analysis of the klang of the voice in the different vowels was effected by tuning forks applied to the mouth in its different positions and by the method with resonators, already described. By this latter means it was found that in almost all cases the first 6 or 8 harmonics were distinctly audible, but that the characteristic note was predominant.



Thus, when the ear was provided with a resonator tuned to B flat, on the third line, and a bass voice was made to sing the different vowels on the notes of which this B flat is the 1st, 2nd, 3rd, 4th, and 5th harmonic, on each note, when O was sung, the resonance was

very strong; with A it was moderately strong; and with the other vowels feeble or absent altogether. If, on the other hand, the resonator was tuned an octave higher, the strongest resonance was got with A.

The synthesis of the vowels was effected by the arrangement of vibrating tuning forks already mentioned, and the results were found to agree with those got by analysis. A very simple mode of reproducing the vowel sounds is the following: Raise the dampers from the strings of a piano by depressing the loud pedal, and then sing strongly the different vowels, the echo given back by the instrument will exactly imitate the sound of the voice, reproducing always the vowel sung. The strings are a series of tuned resonators, and vibrate in unison with all the tones of the klang, giving to each its due amount of strength.

The different vocal registers are also varieties in the timbre of the voice. As one sings up the scale an increasing feeling of tension and effort is experienced, but when a certain point is reached, it is possible to change into the falsetto voice, by which change the feeling of strain is at once relieved, and the ascent can be continued without effort. The falsetto has a softer, more fluty character than the chest voice, and although much less muscular effort is required, a much greater expenditure of breath is necessary to sing in the former than in the latter register. Both in men and women the change from the chest into the falsetto takes place at about G on the second line in the treble stave; but the chest voice can be carried higher, and the falsetto lower than this point, so that many notes can be sung in either register. Women speak and sing for the most part in the falsetto, men in the chest voice.

When singing in the chest voice the vocal chords vibrate in their whole length, when in falsetto only in their anterior portion. The posterior parts of opposite sides in the neighbourhood of the arytenoid cartilages, touch each other and remain at rest.

The upper part of the falsetto voice is distinguished by great brilliancy of tone, and is by singing masters generally classified as a separate register under the name of head voice (voce di testa). Of the mode of production of the other registers, such as the mixed voice, the counterbass register, &c., little is known; indeed their very existence is denied by some professors.

In conclusion, there is a word to be said about what are called the sombre or grave, and the hard or bright timbres, by the judicious use of which some of the chief effects of dramatic singing are produced. When one sings up the scale, the larynx as a whole rises in the neck; at the moment of change into falsetto, the larynx suddenly falls, to rise again gradually as the voice ascends through the falsetto register. Garcia states that, when the grave or sombre timbre is employed, the larynx remains at its lowest position, and does not rise, and to this depressed state of the organ he mainly attributes the grave tone. This immobility of the larynx is to a certain extent true, but it appears that the grave tone is produced by the imperfect pronunciation of the vowels; the orifice of the mouth is narrowed, while the posterior parts are

enlarged (it is probably to effect this that the larynx is maintained in its deep position, and that the head is depressed); by this means the higher harmonics of the vocal klang are weakened, and the sounds of the different vowels are much less sharply distinguished than when they are produced in the hard tone. By this means it is probable that a feeling of mental confusion and uncertainty is caused, analogous to that which Helmholtz supposes to be produced by the use of the harmony of a minor key, and to this mental state is to be attributed the gloomy and mysterious effect of minor harmony, and of passages sung in the sombre tone.

XXXVI.—"*On the Theory of Heat, and some of its Applications to Arts and Manufactures.*" Being the substance of a Discourse delivered by ALEXANDER MAC DONNELL, C. E., on Monday Evening, 21st April, 1873.

THE subject of Heat is so extensive and varied, that it would be quite impossible, in a single evening, to do more than touch on the most important part. It must, in the first instance, be taken for granted that you are well acquainted with such things as the construction of thermometers, the contraction and expansion of substances subject to cold and heat, &c. Since Mr. Joule gave the value of the mechanical equivalent of heat, about thirty years ago, a very great advance has been made in the mechanical application of heat. Whenever a force is applied to overcome a resistance a certain definite amount of work is performed, and the amount of work done is measured by the product of the resistance, and the distance through which it is overcome. When one pound weight is raised one foot high, an amount of work is performed, and this quantity is generally taken as the unit of work, and is called a foot pound. The term energy is used to express the quantity of work a body can perform, potential energy being that due to its position, and actual or kinetic energy being that due to its motion. Thus lifting a body confers on it potential energy equal to the amount of work performed, and when it is allowed to fall freely it will acquire kinetic energy equal to the potential energy lost. The work done by a force F through a space S, is equal to $FS = \frac{1}{2} MV^2$, (M being the mass of the body, and V the velocity given by the force acting through the space S) = the kinetic energy of the body = half the *vis viva*. Thus when an amount of work is performed by a force F, raising a body through a vertical space S, the body acquires an amount of potential energy equal to FS., due to its new position, and when the body falls through the space S, and acquires a velocity V it will have converted its potential energy into its equivalent amount of actual or kinetic energy $\frac{1}{2} MV^2$.

In this case the force is exerted to raise a body and overcome the force of gravity, but there are many other forces, such as magnetism, chemical affinity, &c., and there is a similar variety of forms of energy.

For instance, the atoms of oxygen and carbon have a very strong attraction, although only when the particles are at an insensible distance. When the atoms of oxygen and carbon are separated there is an energy of position, potential energy, or power of performing work. When the atoms of oxygen and carbon are allowed to rush together through the small space within which chemical attraction acts, they acquire, through the intensity of the attracting force, very great velocity. The primary result is the form of energy we call heat, so that as the fall of the body under the influence of gravity denotes motion on a visible scale, so the motion of the particles on a small scale may denote heat. When we employ this motion of the oxygen and carbon particles, or this energy of heat, to work a steam engine, we utilise the motion as truly as when the fall of water is employed to drive a water wheel. There is then both visible energy of position, or potential, and of actual motion, or kinetic, and also a molecular or invisible energy of the atoms, one of the forms of which we call heat. When by the combustion of the carbon a body becomes heated, its molecules are in a state of intense motion, although the body is at rest, and the intensity of this motion of the particles is measured by the temperature of the body. In some cases the temperature of the body does not alter, although it may receive a large amount of heat, as in the case of water being converted into steam. In this case the heat which has not increased the temperature is rendered latent, and has expended itself in forcing the particles of the water apart, so that the energy of motion has passed into energy of position, or potential energy; sensible heat being a form of kinetic energy, and latent heat being potential energy. The different forms of energy, as chemical affinity, electricity in motion, radiant light and heat, &c., can be converted into each other, and the principle of the conservation of energy governs such transmutations. When a body is moving and suddenly is brought to rest, as when a rifle shot strikes a target, its energy is not destroyed, but it is converted into heat. Its visible motion ceases and an invisible motion of the molecules of the body commences. The potential energy of the powder is converted through the chemical action of the explosion into the actual energy of the shot, and this is again converted into the energy of heat when the shot strikes the target. There is not the slightest difficulty in showing the conversion of mechanical energy into heat, and by means of the thermo-electric pile the very most minute amount of heat produced can be made apparent. In this way it can be shown that heat is produced in cases where it might be supposed at first sight that the mechanical energy was lost, but in which, in reality, the equivalent amount of heat is merely so slight that the ordinary methods are not sufficiently delicate to detect it. It is well known that if a piece of iron is struck very rapidly it will become heated to a considerable extent; the turnings from a piece of iron or steel which

are cut off in a lathe are extremely hot; if a piece of steel is bent without breaking it the bent part is heated. When a body falling from a height is suddenly brought to rest by striking the ground its energy is converted into heat, although generally this is not quite evident on account of the amount of heat being so slight. However, a few experiments with the thermo-electric pile exhibit this small amount of heat in a way just as evident as if it could be felt by the hand. The exact numerical relations between mechanical energy and heat was first established by Mr. Joule, in England, and M. Meyer, in Germany, about thirty years ago; when it was found that the mechanical energy of a pound weight falling 772 feet was sufficient, if all converted into heat, to raise a pound of water one degree in temperature. One pound weight falling 772 feet, or as it is generally called 772 foot pounds, is the mechanical equivalent of one unit of heat. A body falling this distance (772 feet) acquires a velocity of about 200 feet per second, which is about one-sixth the velocity of a cannon shot, so that the energy of the cannon shot is about 36 times as great as if it fell 772 feet. If none of this energy is expended in breaking up the shot or piercing the target, but is all expended in heating the shot when it strikes, the amount of heat will be sufficient to heat a weight of water equal to the weight of the shot, 36 degrees. Since the specific heat of iron is about a tenth that of water, this amount of heat will be sufficient to raise the temperature of the shot about 360 degrees. If the shot were lead, which has a still lower specific heat than iron, the temperature would be about 1000 degrees. The lead, however, is always broken up, and generally melted by the blow.

When a certain definite quantity of heat is applied to a body sufficient to raise its temperature, say one degree, the quantity depending on its specific heat, it is utilised in two different ways. Some of the heat is employed in overcoming the force of cohesion of the particles of the substance, and causing the expansion which we know takes place when a body is heated. This portion takes the form of potential energy, and does not affect the thermometer; the remainder of the heat is employed in producing a movement of the molecules or ultimate particles of the body, and takes the form of kinetic energy, causing the body to feel hotter, and affecting the thermometer. Different substances require different amounts of heat for these two purposes, so that different quantities of heat are required to produce an increase of one degree in temperature in different substances, or, in other words, the specific heat for different substances varies according to their molecular constitution. In ordinary cases the greater part of the heat takes the form of kinetic energy, and raises the temperature of the body. There are, however, certain cases, when a body changes its state from solid to liquid, or from liquid to vapour, when a large amount of heat is received by the body without any change in temperature. The heat is then said to be rendered latent, and is really spent in forcing the molecules apart, against the force of cohesion, taking the form of potential energy.

A hot body parts with its heat partly by conduction and partly by radiation. The motion of the molecules of a hot body is given to the medium which surrounds them, which is called the luminiferous ether, and is propagated through it in a series of waves, moving at a great velocity. This wave motion of the luminiferous ether is called light or radiant heat—being called light when we perceive it by means of the eye, and radiant heat when we feel it by the sensation of heat, or discover it by the thermometer. An ordinary radiant beam consists of waves of different lengths, and we can separate the different wave lengths by passing the beam through a prism. We are able to detect the waves of different lengths by their chemical effects, by the eye, and by means of the thermometer or the thermo-electric pile. When the spectrum of a radiant beam is examined it is found that a luminous effect is produced on the eye only by the waves of certain lengths, varying between 30,000 and 70,000ths of an inch, the different colours being due to different wave lengths. The thermo-electric pile detects a greater amount of heat below the red rays of the spectrum, where the length of the waves is greater, but where no luminous effect is produced on the eye; and the chemical effects are found to be greater above the violet, where the wave lengths are shortest, and where neither light can be detected by the eye nor heat by the thermo-electric pile. The amount of energy of a radiant ray is measured by the heating effect when it is absorbed by any substance, or when the wave motion is used to produce motion of the molecules of the absorbing body. The chemical effect of a radiation is no measure of its energy, but is probably produced by properly timed vibrations, shaking asunder the atoms which are held together to form compound molecules by an unstable chemical affinity. The effect, which may be very great, is not a dynamical measure of the cause, in the same way that the effect of an avalanche is not in any way a measure of the slight force exerted in the first instance to start it.

If we examine the visible part of a radiation we find that some substances are transparent, or allow certain rays to pass through them, while they absorb other rays; as, for instance, a piece of red glass allows the red rays to pass through, but absorbs the other rays. In such cases the molecules of the substances are able to take up from the luminiferous ether the vibrations of the rays which it absorbs, but cannot absorb the vibrations of the rays to which it is transparent. When a ray of dark heat is examined, it is found in a similar way that certain substances allow some rays to pass through, and absorb others. As the molecules of certain substances are in this way able to take up or absorb the vibrations of the luminiferous ether for particular rays, so they can produce in the luminiferous ether the vibrations for the same rays. Therefore a substance radiates the same rays which it absorbs, and a good radiator is a good absorber. Dark heat is found to pass very freely through rock salt, in the same way that light passes through glass; while alum is found to be extremely opaque to dark heat, but quite transparent to light. A solution of iodine in sulphide of carbon is

very transparent to the dark rays of heat, and is opaque to light; so that when a ray is passed through such a solution the dark rays can be separated from the luminous rays, and these dark rays can be afterwards concentrated to a focus by a lens of rock salt, or by a reflector. The dark rays of an electric lamp produce intense heat at the focus, so that gun cotton is exploded, matches are ignited, and if the source of heat is sufficiently great even platinum can be brought to a white heat, showing the transformation of dark radiant heat into light, which has been called colorescence. The molecules of any particular substance are supposed to be capable of vibrating freely only in certain periods; in the case of solids and liquids the vibrations may be of any period lying within certain limits, but in gases the periods are defined, so that the molecules can only vibrate in unison with certain vibrations. When a radiant beam, which consists of waves of different lengths, comes to the surface of a body, part of the beam is reflected, part transmitted, and part absorbed. The vibrations of certain periods in the luminiferous ether are capable of exciting vibrations of the same period in the molecules of the body, the wave corresponding to these particular vibrations in the ether disappears, and the body absorbs that part of the beam, and becomes heated. The molecules of the body not being able to vibrate in unison with the other waves of the beam, they pass through without absorption, and are transmitted. The molecules of a hot body in the same way produce vibrations of a similar period in the ether, and the body then radiates waves of a similar kind to those which it absorbs. When a ray of light passes through a piece of coloured glass certain colours are selected for absorption and the colour of the rays which are transmitted determines what we call the colour of the glass. If the glass became itself luminous, it would give out the same colour which it absorbed. Many examples of this can be mentioned. A piece of red glass, for instance, if heated to a high heat, and examined in the dark, is found to give out a green light. A body which is diathermous, or transparent to heat, is not transparent to all kinds of heat, but is particularly opaque to the kind of heat which it radiates itself—that is, it is opaque to, or it absorbs, the same kind of heat which it radiates when heated. Rock salt, which is very transparent to most kinds of heat, is very opaque to the heat given out by another piece of rock salt; lamp-black absorbs nearly the whole of any visible radiation which falls on it, reflecting very little, and transmitting none; while white lead reflects nearly all the luminous part, and absorbs nearly all the heat rays.

The blackness of lamp-black is due to its molecules being able to vibrate in unison with waves of the visible spectrum, all of which it can absorb. It can, however, emit them all, for the whitest light of our lamps comes from this lamp-black in an incandescent state. Carbonic acid gas absorbs very little of the dark heat given out from heated solids, but it is a powerful absorber of the heat given out by the carbonic acid formed by the combustion of a flame of carbonic oxide. Water is very transparent to all luminous rays, but absorbs most of the heat given

out by bodies which are not incandescent; some heat, however, passes through water, but this heat, although it affects the thermo-electric pile, is quite incapable of melting ice. The more diathermic a body is, the more difficult it is to warm it by radiant heat. Sugar, for instance, will be highly heated by exposure to heat which will scarcely warm common salt; phosphorus can be kept for some time in the dark focus of an electric lamp without catching fire, while a piece of platinum is at once raised to a white heat, and bisulphide of carbon is hardly warmed in the focus when exposed for a time sufficient to boil water.

We have seen that there is potential energy between the molecules of two bodies which, if they had the opportunity, would combine chemically. When they do combine chemically the molecules rush together, the potential energy being converted into actual or kinetic energy, or the molecules acquire the movement which we call heat. The amount of heat produced by chemical combination or combustion is quite definite for different substances, so that a pound of carbon, for instance, when burnt, produces always the same amount of heat. The quantity of heat is estimated either in foot-pounds, which is its mechanical equivalent, or by the number of pounds of water which can be raised one degree in temperature. The heat necessary to raise one pound of water one degree in temperature is called a unit of heat, and has for its mechanical equivalent the raising one pound 772 feet high, or 772 foot-pounds. One-horse power, which is equivalent to 33,000 foot-pounds produced in a minute, is equal to the production of 42·75 units of heat in a minute. The total heat of combustion of a pound of carbon is 11,186,280 foot-pounds, or 14,490 units of heat, and the heat of combustion of a pound of hydrogen is 47,728,128 foot-pounds, or 61,824 units of heat. If it were possible then in practice to convert all the heat of combustion into mechanical effect, the heat produced by the combustion of one pound of carbon in a minute would be equal to 339 horse-power. When heat is converted into mechanical effect by means of a steam engine, a large amount of the total heat is lost as mechanical effect, and a great deal of this loss is absolutely necessary. The heat required to convert ice into water is 143 units, and that required to convert water into steam is 966 units.

One pound of carbon requires 2·66 lbs. of oxygen for its complete combustion, which is mixed in the air with 8·93 lbs. of nitrogen, so that the products of combustion of a pound of carbon will be 3·66 lbs. of carbonic acid, and 8·93 lbs. of nitrogen, or 12·59 lbs. of waste gases. The total waste gases from the combustion of a pound of hydrogen will be 35·8 lbs. Average coal, containing 80 per cent. of carbon and 5 per cent. of hydrogen, will by the combustion of one pound produce 11·86 lbs. of waste gases, and the total heat will be 15,002 units. The waste gases must pass off at a higher temperature than the steam, and they will carry off with them at least 1460 units of heat if they take away an increased temperature of 500°. The remaining heat, 14,542 units, if all used in converting water at 120° into steam at 360°, would be sufficient to evaporate 12·3 lbs. of water. If the steam were used in a high-pressure engine the steam would carry away the whole of the latent

heat, which for 12·3 lbs. would equal 11,881 units, and if the gases were admitted into the cylinder at a temperature of 360°, and expanded without condensation until its temperature fell to 212°, the maximum heat converted into work would be 2201 units, so that of the 15,002 units of heat in a pound of coal, not more than 2201 units can be converted into work in a high-pressure engine. In practice it is considered a fairly good result if a pound of coal converts nine pounds of water into steam, in which case 3521 units of heat would be lost in the waste gases, bad combustion, and radiation; 8694 units of heat would pass off as latent heat, and 1611 units would be the most which could be converted into work if no condensation took place in the cylinder. The following excellent result was obtained in practice in a condensing engine:—

Heat carried off by waste gases, . . .	1,620	units.
" " by condenser, . . .	10,657	"
" " by steam jacket, . .	105	"
Lost by radiation, ...	359	"
Converted into work, ...	1,351	"

Such a result as this is seldom obtained; many engines not evaporating more than 4 lbs. of water for a pound of coal, and losing from the construction and condensation in the cylinder a large proportion of the heat which might be converted into work. Waste of heat in a steam engine is sometimes caused by a badly constructed boiler, when the fuel is not properly consumed, or where some of the heat is allowed to escape which might have been taken up by the water; sometimes by bad firing, when the fireman allows either too much or too little air, by the perfect combustion of the fuel, and sometimes from bad construction in the engine itself, when the steam produced is not used to the best advantage.

The greatest loss generally arises from imperfect combustion of the fuel from either a badly constructed boiler or from bad firing. If the oxygen supplied is only sufficient to form carbonic oxide, the heat produced by a pound of carbon is 4520 units. If, therefore, ten per cent. of the carbon in a pound of average coal is only converted into carbonic oxide there will be a loss of heat from this cause of 829 units, the combustion of the coal producing only 14,173 units instead of 15,000 units of heat. During the last twenty-five years great improvements have taken place in steam engines; the quantity of coal used in marine engines, for instance, not being now more than 50 per cent. of that used in 1850. Many marine engines are stated now to evaporate 9 lbs. of water for each pound of coal.

About $\frac{1}{3}$th of the coal annually raised in Britain is absorbed in the iron trade. Several of the later improvements in the manufacture of gas have effected considerable economy in fuel. An attempt has been made with a certain amount of success to use the heat of the waste gases from blast furnaces to heat the air of the blast. The top of the blast furnace is closed generally with a kind of cast-iron ball, which can be lowered to allow the ore and fuel to fall into the furnace. The waste

gases, containing a considerable quantity of carbonic oxide, are carried off through a large tube to an oven of great size, filled with fire-brick, placed so that the gases can pass through; at the bottom a sufficient quantity of air is admitted to complete the combustion of the carbonic oxide. When the fire-brick is heated by the waste gases they are turned into another similar oven, and the air which is driven into the blast furnace is passed through the first, taking up the heat from the heated fire-brick. In this way the temperature of the blast is, if required, considerably increased, and the coal used to heat the blast is economised. Generally the temperature of the blast entering a blast furnace is about 1000°. The quantity of coke required to smelt a ton of iron in a blast furnace of good construction varies from 26 to 30 hundred weight, the minimum theoretical quantity being about 20 hundred weight. It is roughly estimated that the coke required to reduce a ton of iron from ore containing 40 per cent. of iron is utilised as follows:—

Melting iron, ...	1·60 cwts.
Melting cinder, ...	4·13 ,,
Heat rendered latent in reducing ore,	3·19 ,,
Carbonising iron and oxygen of ore,	7·43 ,,
Ashes and water, ...	1·63 ,,
Calcining limestone, ...	1·63 ,,
Total coke required,	19·61

In some cases, where very high temperature is required in manufactures, it is absolutely necessary that there should be no free oxygen in the waste gases, so that the air admitted to the fuel should not be quite sufficient for its complete combustion. In this case some carbonic oxide must be allowed to escape with the waste gases; in other cases there is no harm in having free oxygen present, as when steel is melted in crucibles. In such cases of extremely high temperature the heat is communicated to the steel, when it is near the melting point, extremely slowly, the result of which is that there is an excessive waste of fuel and great wear and tear of the furnace. The actual amount of heat utilised in melting a ton of steel is not more than 25 per cent. more than that necessary to melt an equal quantity of cast iron. Therefore, in cases where an extremely high temperature is required it is of great importance that the air, before entering into combustion, and if possible the fuel, should be at a high temperature, so as to increase as much as possible the intensity of the heat. One of the most successful furnaces for producing high temperature economically and with inferior fuel is Siemens' Regenerative Gas Furnace; it consists of two parts—the producers, where the fuel is converted into gas, and the regenerative furnace, in which the gases from the producers are consumed. The gas producer is a large fire-brick chamber, one side of which is inclined at an angle of about 45°, with a grate at the bottom. The oxygen of the air which passes through the grate unites with the carbon of the fuel, forming

carbonic acid, which, rising through the mass of ignited fuel, takes up another equivalent of carbon, and forms carbonic oxide. The heat produced distils the carburetted hydrogen and other gases from the fuel, which, with the carbonic oxide and the nitrogen of the air, rise to the top of the chamber, and are carried through a tube to the furnace. These mixed gases contain on an average about 35 per cent. of combustible gas and 65 per cent. of nitrogen, with a small quantity of carbonic acid. The furnace is constructed with four chambers, underneath, which are filled with fire-brick, placed loosely, with spaces between them. A system of valves admits the gas through one of these chambers and air through another. As the gas and air, after passing through these chambers, enter the furnace they ignite, the flame passes over the floor of the furnace, and the waste gases, at a high temperature, pass down through the other two chambers, giving up their heat to the fire-brick, and finally ascend through the chimney, at a temperature of about 300°. After from half an hour to an hour, according to circumstances, the valves are reversed, and the gas and air enter the furnace through the two chambers, in which the fire-brick has been heated by the waste gases, taking up the heat from the fire-brick, and the waste gases pass down through the chamber, through which the gas and air entered in the first instance. In this way the gas and air are very highly heated by means of the waste heat from the furnace before they enter into combustion, and the quantity of gas and air can be regulated so as to produce the heat required, and the flame can be made of any quality required, either reducing or oxydising. These furnaces have been very successfully applied to the manufacture of iron, steel, and glass, effecting a saving of from 40 to 50 per cent. in fuel, and allowing very inferior fuel, with which it would be impossible in an ordinary furnace to obtain sufficiently high temperature, to be employed.

Another very successful furnace in which the air is heated before it comes in contact with the fuel, and in which the waste heat is utilised, is Hoffman's Kiln for burning bricks, lime, &c. These ovens or kilns are built in a ring with a chimney in the centre. When in operation the first oven is generally being filled with fresh brick, and the burnt brick is being taken out of the second. There is no partition between the ovens except between the first and last, and the last only has a communication with the central chimney. The air enters through the doors of the first two ovens, which are open to allow the bricks to be taken out and put in, and passes through the burnt and hot bricks in the third and fourth ovens. The bricks are cooled, and the air heated in this way before it enters the next ovens, where the bricks are being burnt, the fuel being introduced through holes in the top. After combustion the waste gases pass on through the next set of ovens, heating and drying the bricks in them, and finally pass through the last oven to the chimney. After a certain time, and when the first oven is filled with fresh unburnt brick, the partition is moved forward between the first and second ovens; the oven which was the first becomes the last; the opening to the chimney being closed in the oven which was the last,

the firing is moved forward to the oven next that last fired. In this way the burning goes on continually.

An extremely ingenious method of diffusing heat is shown in Perkins' high-pressure water-heating system, and in Perkins' baking oven. The baking oven is formed by a number of straight tubes of iron, of small diameter, nearly filled with water, and closed at both ends. Half of the tubes, which are slightly inclined, and laid close together, form the bottom, and the other half the top of the oven. The ends pass through a fire-brick wall, and project for a few inches into a fire. The water, when heated by the fire, circulates through each tube, and a very uniform and easily regulated heat is diffused through the oven. Many of these ovens are in use as military field ovens, and are considered, I believe, very good, and portable. Time does not permit me to touch on many more interesting arrangements, as, for instance, the use of dust fuel, or fuel in the liquid state; as I have already very much exceeded the limits usually allowed.

XXXVII.—*On the Use of Peat in Siemens' Regenerative Gas Furnace.* By ALEXANDER MAC DONNELL, C. E.

[Read Monday Evening, May 18, 1874.]

THE principle of the Regenerative Gas Furnace is so well established and so well known as to require no detailed explanation, so that I need only draw attention to the general arrangement. When an extremely high temperature is required it is generally necessary, if solid fuel is used, to employ it in a very concentrated state; this is nearly always an extremely expensive form of fuel, and therefore many attempts have been made with more or less success to produce very high temperature with inferior fuel. In the Regenerative Gas Furnace the whole of the fuel is burnt in the form of gas. The gas producer is a rectangular brick chamber with one side inclined, and has a grate at the bottom. The fuel is charged through a box or hopper at the top, and falls in a thick mass on the grate and sloping side. The air entering through the grate forms, with the carbon of the fuel at the bottom, carbonic acid, which, rising through the ignited fuel, takes up another equivalent of carbon and forms carbonic oxide. The hydro-carbons and the moisture are distilled by the heat, and the carbonic oxide, mixed with these and diluted with nitrogen, rises to the top of the chamber of the producer, and is carried off through the tube to the furnace.

In passing through the tube the gases are cooled, and moisture and tar are condensed.

The furnace is built with four chambers underneath, filled with fire-brick, stacked loosely together with spaces between. The gas which passes from the producer through the cooling tube enters the furnace through one of these chambers; the air necessary for combustion passing through the one next it. The air and gas meet on entering

the furnace, when combustion takes place, and the combined gases, with the waste heat of combustion, pass away to the chimney through the other two chambers, giving up a large quantity of heat to the fire-brick. After a time, when the fire-brick has become heated (generally about half an hour), a properly arranged system of valves are turned, and the cold air and gas enter through the two heated chambers, becoming heated while passing through the fire-brick. The gases, with the waste heat of combustion, then pass away to the flue through the chambers through which the air and gas formerly entered.

By thus reversing the current regularly, almost all the heat of combustion is retained in the furnace, and an extremely high temperature can be obtained, so that there is no difficulty in obtaining a full welding heat for iron, which is estimated at 2900°, F., or the melting heat of steel, which is 4000°, F.

It will be seen at once that the disadvantages of peat as a fuel, its bulk, its dampness, and its want of concentration, do not prevent its being used with advantage in such a furnace.

The moisture of the peat must of course be driven off, but even when the peat is very damp this is done in an inexpensive way, and when the cooling tube is sufficiently long the vapour is condensed, so that it does not injure the inflammable gases. I do not think that the water contained in the peat in the form of moisture is decomposed in the gas producer, as it is distilled off at too low a temperature. There is of course a slight loss of heat in vapourising the moisture, and again in cooling the gas so as to condense the vapour; but this latter loss is very slight, as there is hardly anything gained by allowing the gas to enter the regenerative chamber at a high temperature. The temperature of the waste gases, as they pass away through the flue, must be at least as great as the temperature of the gas entering the regenerative chamber. The condensed water and tar run off mixed, from one end of the cooling tube, in a constant stream. The tar does not separate to any great extent from the water until heated to a temperature of about 180°, F. I have given Dr. Reynolds' samples of the gas, the condensed water, and the tar, from the furnace at the Inchicore Works, and he will probably be able to give the Society information as to their chemical composition, and commercial value. I have found in practice that peat answers extremely well in a furnace for heating iron to a welding heat to be forged under a steam hammer; and unless the peat is very damp, the water exceeding, I should say roughly, nearly 40 per cent., I have not found that the heat in the furnace has been effected by it. The furnace in which I have used peat was lit on February 10, 1874, and since that time it has never been at a lower temperature than a bright white heat. Before this Siemens' furnace was built, the iron was heated in an air furnace, and the average quantity of coal required for forging a ton of iron, from scrap iron to finished forging, was 4·96 tons, on an average of six months The result of the use of peat for ten weeks in Siemens' gas furnace is, that a ton of iron has been forged with 5·09 tons of peat. A ton of peat, therefore, when used in Siemens' furnace performs as much duty as a

ton of coal in the ordinary air furnace. There are a few other points in which Siemens' furnace is more economical than the air furnace—the waste of iron being less, and the quantity of iron forged in a given time being greater. Taking the price of coal at 28*s.* a ton, and peat at 14*s.* a ton (which was the lowest price I could get it at), the total economy resulting from the use of Siemens' furnace has amounted to £4 7*s.* 9*d.* a ton of finished forgings. In this the comparison has been between coal used in the air furnace and peat used in Siemens' furnace. I am not able to give a very accurate comparison between coal and peat, both being used in Siemens' furnace, as I have only tried coal in it for two weeks, which is not quite long enough to give a fair average. However, the result of this is, that a ton of iron has been forged with 3·63 tons of coal. The coal which can be used in Siemens' furnace may be of an inferior quality, and the price should be taken at probably 3*s.* a ton less than the best coal. Taking, therefore, the price of coal delivered at the furnace at 18*s.* a ton, which would be nearly the present price, the price of peat should not exceed 12*s.* 10*d.* a ton to compete with coal. I should be inclined to put the price of peat rather lower than this, as I think that a longer use of coal in the furnace would show that the consumption could be reduced. Other trials of peat which I have made in steam engines would give a price for peat varying from 8*s.* 6*d.* to 9*s.* a ton, the price of coal being taken at 20*s.* a ton.

I think this trial of peat may be considered a fairly successful one, and I may mention that the success of it was greatly due to the intelligent way the men who were engaged at the furnace applied themselves to their work, many of them never having seen, and I believe none of them ever having worked, a furnace of the kind.

NOTE.—A longer use of coal in Siemens' Furnace gave a ton of iron forged with 2·75 tons of coal. This would give 9*s.* 9*d.* as the price of peat to compete with coal at 18*s.* a ton.

XXXVIII.—*On Glaciers, Ancient and Modern, being the Abstract of a Discourse* by EDWARD HULL, ESQ., F. R. S., Professor of Geology, Royal College of Science; Director of the Geological Survey of Ireland.

[Delivered Monday Evening, February 16, 1874.]

MR. HULL said that the sight of the snow-fields which accumulate on high mountains was one of the most impressive to a traveller viewing it for the first time. But if the accumulation of snow and ice on the higher parts of the globe was not regulated, it would in the course of ages interfere with the balance of nature and the stability of the world. But this was prevented by glaciers, which are to snow-fields what sluices and weirs are to reservoirs. The main function of glaciers is to check the accumulation of snow on the mountains; but the next most

useful purpose which they fulfil is to irrigate the lowlands, especially in the season when this is most required. Glaciers are rivers of ice; and the masses of snow become converted into ice by pressure, the transitional point being at their junction with the snow-fields; at the *nevée*. It has long been known that glaciers moved; and they have sometimes invaded and destroyed villages; but it is only recently that the details of this phenomenon have been ascertained by Professor Agassiz and Professor James Forbes, and the results published in his "Travels in the Alps." The investigation was first undertaken by Professor Agassiz. M. Hugi erected a cabin on the Aar glacier in 1827, and Professor Agassiz discovered that between 1827 and 1830 it had moved 100 metres, or 110 yards. In 1836 it had moved 714, and in 1841, 1428 metres from its original position, giving an average of 110 yards per annum. In 1841 Agassiz commenced experiments on the Aar and Finster Aar glaciers, and wrote to Professor Forbes to assist him. In the meantime he commenced operations himself, by taking up his position on one side of the glacier with a theodolite, and planting a row of stakes in holes cut in the ice at intervals of 100 metres. The stakes at 100 metres from the bank moved 160 feet in a year; that at 200, 225; that at 300, in the centre of the glacier, 369 feet. Therefore, the glacier moved most rapidly in the centre, as is the case with a river. Forbes subsequently commenced experiments on the Mer de Glace, and came to the same conclusions respecting glacier motion. This determines the cause of the motion to be mainly gravity. Dr. Tyndall, having studied the researches of his predecessors, continued them. When a river bends, its maximum velocity is not in the centre of the channel. Tyndall and Prest made transverse observations on the Mer de Glace at different points where it bends, and found that in this particular also the motion corresponds with that of a river. A glacier is, therefore, when viewed on a large scale, a plastic mass, capable of moving like water, but much slower. Three different classes of effects are produced by a glacier in moving down its valley. First, the glacier polishes and scores its bed and sides. Thus, the marks which former ice has left can be pointed out. The glacier has a double motion: the upper surface moves more rapidly than the sides and bottom, and the mass also slides bodily down its bed. Whenever, therefore, it holds a stone or hard material embedded in its mass, which comes in contact with the sides or bottom, it scores the surface over which it moves. The second effect is to transport rocks from one part of the mountain to another. Almost every glacier carries down large masses of loose rock. These form streams of rock, called moraines, medial and lateral. The stones are not continued down into the mass of the ice, but are carried on the surface, the glacier always tending to cast any blocks which may be embedded in its mass up to the surface. The cliffs and masses of rock above a glacier are constantly crumbling and discharging loose rock upon its surface, especially in spring. These are finally discharged at the lower end of the glacier, and form what are called "terminal moraines." The size of a terminal moraine forms the measure of the amount of work done by the glacier in carrying

down masses of rock. We sometimes see a large mass of stone on a glacier, supported by a slender pillar of ice. This represents the amount to which the glacier has been melted away by the summer heat, while the pedestal, being in the shade, has not melted. If the glacier were dried up, the moraines and rocks would be left stranded under the places they had occupied. If such deposits were found among mountains which now retain no proper snow-fields or glaciers, we may conclude that former ice was the agent. The fourth effect of glaciers is to pen up the waters of a valley into the form of lakes, or to scoop out hollows in the solid rock itself, and thus produce lakes. Glaciers are the cause of a large number of lakes, either by throwing great moraines across valleys, or by producing true rock-basins. This was first pointed out by Professor Ramsay. We may ask if glaciers were formerly more extended than at the present day. Traces of glaciers, such as scorings, moraines, and perched blocks, &c., occur in the Swiss valleys, far below any existing glaciers. This was first observed by De Saussure, and subsequently by Charpentier, Agassiz, &c. They concluded that the glaciers of the Alps were formerly far more extended than at the present day, and that their effects are found far from existing glaciers. The Swiss Alps are twenty or thirty miles from the Jura, and are divided by the valley of Geneva. There are great boulders on the flanks of the Jura, which have been carried all across the valley, and stranded several hundred feet above the town of Geneva. There is one block of granitic gneiss, called "Pierre-a-Bôt," so large that a considerable quarry was opened in it, which was evidently carried thirty or forty miles across the great plain, from the neighbourhood of Mont Blanc, by a glacier. A glacier must have filled this great valley to the height of 1000 feet or so above its present surface. The great block above referred to has been purchased by the town of Geneva to prevent its being quarried quite away.

The great glaciers of the Himalayas, and those of northern and middle Europe, also extended far lower than at the present day. At a former period, as indicated by Sir Roderic Murchison, by the limit of erratic blocks drifted by icebergs, or carried on an ice-sheet, from Scandinavia,* all the land above water north of the middle of Germany and Russia must have been covered with ice, having a general motion from north and north-west towards the south and south-east. On examining the valleys of North Wales and Cumberland, Agassiz discovered that the highlands of Britain had formerly been the seats of snow-fields and glaciers. The highlands and lowlands of Scotland also exhibit traces of glacial action: the rocks are polished, boulders have been transported, lakes formed and scooped out, lateral and medial moraines deposited. Nearly the whole of Ireland was, likewise, formerly the seat of glacial action. Whenever the rocky surface is denuded of its covering of boulder clay, which is itself of glacial formation, this surface is observed to be polished, grooved, and striated generally in pa-

* As shown on his Geological Map of Europe.

rallel lines, indicating the direction of the ice-movement. The coast towards Howth is glaciated or covered with boulder clay, and strewn with transported boulders. The directions of the lines indicate the direction in which the ice has moved. This has been determined by the Rev. M. H. Close with remarkable precision.* The central plain of Ireland was the seat of an enormous mass of snow, several thousand feet, perhaps, in depth, which forced the accumulated ice out at its edges in several directions, even over hills which lay in the track. But in the north-east of Ireland the ice does not seem to have come from the centre, but from Scotland,† and moved in a south-westerly direction. The phenomena in the centre of Ireland were not produced by genuine glaciers, but rather by a vast sheet of ice and snow covering the whole country, similar to that which covers Greenland at the present day. This country illustrates the state of all north Europe during the earliest stage of the glacial period. The glacial period may be divided into three sub-periods: 1st sub-period—The country was covered with a great sheet of ice, at the commencement of the extreme refrigeration of the northern hemisphere. At this period the land was elevated considerably above its present altitude, and a portion of the sea was then left dry, and covered with ice. Perhaps it was at this period that the mammoth migrated from Asia and Europe into Britain. 2nd sub-period—The land sunk gradually to 1000 or 1200 feet below its present level. This is called the inter-glacial period, and the climate does not seem to have been very severe. Only a small portion of the present existing land remained above the water, which rose far up the sides of the present mountains, most of which were then islands. We find gravels with sea-shells at a height of 1000 or 1200 feet above the sea: such had been discovered by Mr. Close in Wicklow. 3rd period—The land was again lowered to nearly its present level, and glacial conditions reappeared. Then the British mountains sent down glaciers into the sea, from which floating icebergs became detached. This gradually gave place to the existing condition of things, by retreat of the glaciers up their valleys. As they retreated they left a series of little terminal moraines extending gradually up to the tops of the mountains in Britain. At this period man came upon the scene. There is no evidence of his having existed at the time of the great ice-sheet: man's advent was reserved for a period more fitted to his physical enjoyment; but he was certainly contemporaneous with many of the large mammalia which have since become extinct, such as the mammoth, the great Irish deer, cave bear, *bos primigenius*, &c.

Mr. Porte, with the assistance of Mr. Peake, then exhibited some views of Swiss glaciers on the screen, in illustration of Mr. Hull's discourse.

---

* "On the General Glaciation of Ireland," Journal of the Royal Geological Society, vol. i., part 3, p. 207.

† According to observations taken at Fair Head, Co. Antrim, in 1871, where the direction of the ice-flow has been from N.E. to S.W.—E. H.

XXXIX.—*On the Nature of Rudimental and Provisional Organs.* Being a Discourse by ALEXANDER MACALISTER, M. D., Professor of Zoology, University of Dublin, and Honorary Professor of Artistic Anatomy, Royal Dublin Society.

[Delivered Monday Evening, December 21st, 1874.]

IN following up the forms composing the Animal Kingdom, from the simplest to the most complicated, we are struck by observing that there is a constant specialization of function taking place, and correlated therewith a differentiation of structure; that is, while in the simple organisms life processes are simple and subject to little variety, every succeeding class has its functions more numerous, more separated, and has organs set apart for their discharge, e. g. while in *Amæba* motion, nutrition, &c., are accomplished by the same material, in *Hydra* a separate set of cells are motor and sentient and others subserve the function of nutrition.

Whatever the nature of the interdependence between the differentiation of structure and of function may be, it is so close that we may establish it as a general rule that the size of an organ is an index of the amount of use made of it. Thus in the tail of a cetacean the muscles are the same in number and position as those in the tail of a cat; but in the former they are proportionally seven times more developed than in the latter; as in the whale the tail is the chief organ of propulsion.

In nearly every form of animal above the worms we come across, in the course of anatomical research, parts which appear incapable of discharging any function; and to some of these the name rudimental organs has been given. Much confusion has arisen from a want of precision in defining such structures, and from confounding three classes of organs together—rudimental, nascent, and provisional. A rudimental organ is the functionless representative of an organ useful in other animals, but which at no period of the life of the individual possessing it ever discharged any duty or subserved any use in the economy. A nascent organ is the first stage of a differentiation for the purpose of performing an incipient function. A provisional organ is one developed and functional at one period only of an animal's life cycle, becoming wasted, often obsolete, in succeeding stages. These three can be most easily understood from examples. Thus, of rudimental organs we may take the muscles in the paddle of a whale, which are rudiments of the forearm group of muscles. As the wrist-joint has in *Balænoptera rostrata* no synovial membrane there can be no action, and all together the contractile substance in the entire forearm of a large whale might not weigh thirty grains. In the *Globiocephalus* (the bottle-nose) and in the Razorback (*Physalus*) there is absolutely no muscular tissue at all, and only fibrous bands replacing the biceps and forearm muscles; and here we may digress to notice that it is eminently characteristic of rudimental organs that they are exceedingly variable; thus in the two forearms of the lesser Rorqual, dissected by Dr. Carte and myself, there

were several discrepancies; and in the specimen of the same form dissected by Mr. Perrin the muscular rudiments, as well as in the *Balænoptera* examined by Dr. Struthers, were different from either. That these muscles are true rudiments and agree with my definition is deducible from the consideration that, even had the wrist a synovial membrane, the force of the contraction of sixty grains of muscle, determined according to Professor Haughton's constants, would not have sufficed to produce the smallest flexion movement.

As an example of a nascent organ we may take the processes of the neuro-muscular cells in *Hydra*, and the motor stratum of *Gregarina gigantea*, the first steps towards the formation of a separate muscular system, or the veins from the swimming bladder of *Protopterus*, which, instead of ending in the pre-auricular part of the inferior vena cava or into the hepato-portal, enter the pericardium, and there dilate previous to opening into the ventricle. This is the foreshadowing of the left auricle of the heart, and of the separate arterial circulation of Sauropsids and Mammals.

As an instance of provisional organs, we may take the eyes of the Barnacle and their shells. These curious crustacea begin life as a free swimming nauplius-like larvæ with a central complex eye, but on becoming sessile they lose this and become quite blind.

Contrasting these two forms of organs with the first, we notice that while rudimental organs are individually variable, nascent and provisional organs are individually constant and similar. Thus in twenty Protopteri the venous arrangement will be found identical in all, or in any number of larval cirripedes the eye is the same in all, while, as already remarked, in the case of genuine rudiments they are scarcely alike in two individuals. Indeed, rudimental organs may be zoologically divided into two classes—first, those always present in the species; and, secondly, those only occasionally present. As an example of the first series, we may take the plica semilunaris in the inner corner of the eye, the rudiment of the third eyelid present in so many lower vertebrates—sharks, reptiles, and birds. As an example of the second series, we may take the supracondyloid process of the human humerus, where we have a rudiment of the constant arrangement in the humeri of so many of the lower Mammals, but one very rarely present in man, only about sixty cases being on record. Many muscular varieties common, but by no means constant, in man, are of this type. There are literally hundreds of such occasional rudiments known—in fact they are far more numerous than those of the first class, and to this we will direct attention in the sequel.

Another mode of classification of these organs is more strictly morphological, according to the nature of the organs which become rudimental. Thus they may be, first, rudiments of organs whose functional representatives exist only in animals much lower in the scale of nature: such structures are known as vanishing organs; or, secondly, rudiments of organs of a more generalized type, whose functional representatives are found in correlated forms: these are called retrograded organs.

There is an essential difference between these two forms of rudiment, which will be the more strongly marked when we study the conditions under which organs become rudimentary. Of vanishing organs, we have examples in the branchial clefts of the higher vertebrates, which never breathe by gills, or in the trace of the left duct of Cuvier in the human heart (Fig. 1, D, *l*; Fig. 2, *d' c*), where we find a rudimental impervious band representing the vein-holding fold of marsupials (Fig. 1, C, *l*) and lower vertebrates.

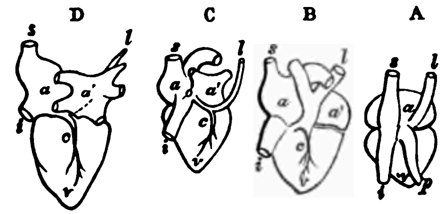


Fig. 1.*

The gradations of arrangement in the vein of the higher as compared with those of the lower vertebrates furnish us with some very striking instances of such rudiments in the process of formation, as will be seen in the accompanying diagram (Fig. 2).

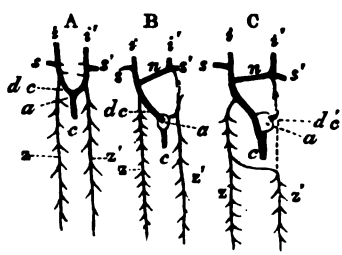


Fig. 2.†

Of retrograded rudiments we have examples in the tooth pulps which exist in the embryo of some parrots and Chelonians; in the embryonic teeth of whalebone whales which never cut the gums; in the useless eyes found in so many cave-dwelling animals, *Proteus*, *Amblyopsis*, &c.; in the aborted index and middle toes of the kangaroo, and the rudimental thumbs of *Colobus* and *Brachyteles*.

It is impossible to contemplate these rudiments (of which I have only given a few examples out of the very many known to anatomists) without reasoning as to the conditions under which these organs become rudimental, and in this connexion we have much to learn from the observation of the history of provisional organs. These may also be grouped morphologically into two categories—first, provisional organs, which are the representatives of organs permanently existing in lower forms; and second, special structures developed for temporary use.

* Fig. 1. Arrangements of vessels entering the heart in Ichthyopsids (A); Reptiles (B); Marsupials (C); and Man (D); *a* = auricle, *a'* = left auricle, *v* = ventricle, *c* = coronary vein, *s* = superior vena cava right, *l* = left superior vena cava, *i* = inferior vena cava.

† Fig. 2. Arrangements of central venous system in embryo (A); Marsupials (B); and Man (C); *a* = sinus venosus, *d c* = right duct of Cuvier, *d c'* = left ditto, *s s'* = subclavian veins, *n* = left vena innominata, *z* = vena azygos, *z'* = vena hemiazygos.

For convenience we may name these representative and special provisional organs respectively. Of the first we have a very good example in the velum of Mollusca (Fig. 5, B and C, *v*), which is a ciliated simple or

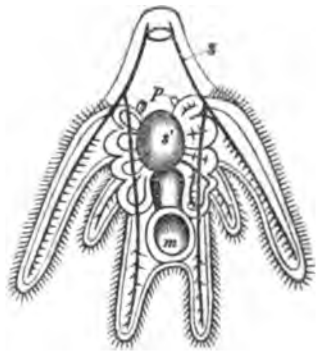


Fig. 3.*

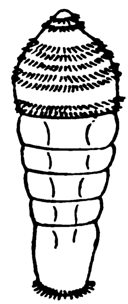


Fig. 4.†

bilobed disk appended to the head of the earliest embryonic stage of a mollusc, lost speedily in the course of growth, and which is identical in position, structure, and nature with the permanent trochal discs of the Rotifers or wheel Animalculæ, or with the ciliary crown in the larvæ

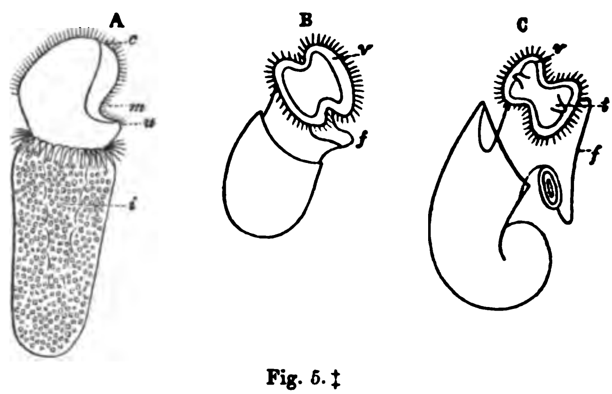


Fig. 5.‡

* Fig. 3. Pluteus larva of an Echinoderm.

† Fig. 4. Polytrochal larva of an Annelid.

‡ Fig. 5. (A) Larva of Annelid, showing the telotrochal type of ciliary crown, with an upper (*c*) and a lower lip (*u*), separated by the mouth; (B) Mollusc larva, with the velum (*v*), comparable with the upper lip of the Annelid larva, and with the foot (*f*) below; (C) Gasteropod larva in a more advanced stage, with tentacles budding (*t*).

of some worms (Fig. 4 and 5, A, c). The relationship can be seen in the cut of these three structures.

This is one of the many testimonies that Comparative Anatomy is bearing to the relationship existing between Mollusca and Worms; for, strange as it may appear, a mollusc is really one joint of a worm expanded and flattened. Another instance of representative provisional organs exists in the gills of Amphibians.

Of independent provisional organs we find instances in the allantois or process of the mesoblast of the chick noticed in the hatching egg, which extends between the layers of the epiblast, and subserves the function of respiration.

We have introduced a notice of these provisional organs for the purpose of collating their history and ultimate fate with what we can determine of the corresponding conditions of rudimental organs proper. Either of two fates befal these provisional organs. As the immature state wherein they are of use merges into the mature condition their occupation is gone, and they begin to waste. As the tadpole loses his swimming tail (itself a provisional organ of the representative class), and gains the use of his legs by their growth, he becomes able to leave the water, and his vesicular airsacs become used as air-breathing organs or lungs; so *pari passu* do his gills shrivel and finally abort altogether, and usually they, like his tail, leave no trace after them. But this total disappearance is not invariable. Thus, the velum which is small and nearly rudimental in the larval *Limnæa* remains as a neck ridge or fringe in the adult, as shown by Mr. Lankester. The ductus

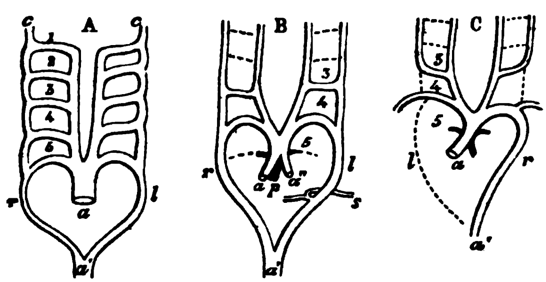


Fig. 6.*

arteriosus (Fig. 7, 5), or tube whereby the pulmonary artery and the aorta communicated in the embryo mammal, is another instance of this kind where a provisional organ remains as a functionless rudiment, forming in the adult an impervious cord; and, while considering this, I may digress to notice a very singular case wherein a very transitory provisional organ may actually remain as a permanent adult condition.

* Fig. 6. (A) Diagram of Embryonic aortic arches; a = cardiac aorta, a' = definitive aorta; (B) Amphibian type; (C) Mammalian type.

From the arch of the aorta in the mammal there normally arise three vessels, as shown in the diagram (Fig. 6, C); but in very rare cases one arises from a very anomalous site, viz., from the very lowest part of the arched part of the aortic tube (Figs. 7, 6, see note). In one case in this city this anomaly caused the death of its possessor; for the anomalous right subclavian artery passing behind the œsophagus, was wounded by a foreign body and caused fatal bleeding. By comparing the diagram of this anomaly with the sketch of an ideal embryonic system in figure 6, A, its mode of origin can easily be understood.

In all these provisional organs, when their occupation is ceasing, we can notice a gradual or sudden decadence of function followed by a wasting of tissue, and often by a perfect disappearance.

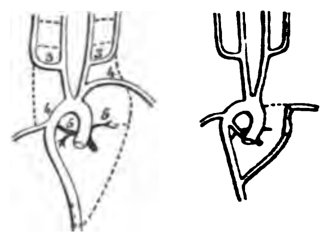


Fig. 7.*

The natural explanation which will most readily occur to any one on considering the causation of the rudimental condition is, that the organs are an inheritance from some ancestor in whom they were functional, and they have atrophied for want of use; but before assuming it to be the true explanation of their existence these queries demand solution: First, have we direct evidence that want of use will cause atrophy of an organ to the rudimental condition? second, have we direct evidence that the atrophied condition can be hereditarily transmitted? third, can we in any series of nearly related forms show that as any function becomes less frequently performed its organ becomes less developed? I think it is manifest that if we can show reason to answer these questions affirmatively, it proves that the regarding of rudimental organs as hereditarily transmitted, disused structures is, to say the least of it, a natural mode of viewing their existence.

Proofs in favour of an affirmative answer to the first of our queries are abundant. If a joint becomes rigid, the muscles above it which should subserve its motion waste and become fatty, losing their contractile material, and often remain only as shreds; and the same has been experimentally demonstrated of other materials. Abundant evidence exists of the correlation of want of use and absence of organs in parasitic forms, as in the Epizoan crustaceans, Pentastomous mites, &c.

The affirmative answer to the second query is harder to prove, but there is some evidence in favour of it. The experiments of Brown Sequard on Guineapigs show that when in these animals the outer toes are wasted, as the result of early division of the peroneal nerve

* Fig. 7. The figures on this block have been accidentally drawn reversed. (A) represents the arterial system of a Mammal; (B) the anomalous condition of origin of the right subclavian, here appearing to the left.

supplying these toes, there is a decided tendency towards the hereditary transmission of that defect. The rearing of many varieties of domestic animals shows that the altered condition of organs can be hereditarily perpetuated. An interesting series of observations bearing on this question I have endeavoured to make on the race of lions, for which Dublin has been so famous. Out of the ninety lions that have been born in the Dublin Zoological Gardens, I have had the opportunity of dissecting a good many, in different stages, and belonging to three distinct generations. The comparisons of these dissections show that some parts seem steadily to be diminishing in size from generation to generation, while others remain constant. Thus the arm protractors and the leg extensors have been steadily diminishing, while the rhomboids, depressors of the humerus, hamstrings, and abductors of the thigh remain tolerably steady. That this is the result of the cage life is evidenced by the fact, that of two tigers—one twelve years in confinement, and the other as many months—the muscles varied a little in the former in the same direction as in the cage-bred lions.

How else can we understand these useless rudiments, but as heirlooms of former structures of use in different conditions of ancestral life? To say, as the Agassizian School do, that they are placed there to the end that they may be signs of unity of type, is, after all, not only an inadequate explanation, as that is in itself not an intelligible end in nature, but it is also a meaningless form of words ; for if there were any real significance in this direction, why should rudiments in the same species be capricious? Is it not as necessary to show that one man belongs to that type (whatever that may mean) as another, and yet why should one be more typically gifted with a supracondyloid process, while a hundred have to do without it? And this argument is cumulative, inasmuch as every occasional rudiment which is discovered strengthens it? That unity of type is just another and more euphuistic phrase for family likeness is the belief of the largest number of those who are competent to form an opinion on the subject, and any other view is, in the view of rudimental organs, simply inconceivable.

The degradation of structure resulting from loss of function is one of the most remarkable, yet intelligible, cases of correlation in the whole range of Biology. Thus changes in external condition will so easily and completely affect forms, that when these changed conditions as factors continue to affect successive generations, they so alter the characters that the descendants are not recognised as of the same species as their ancestors, which are classed as extinct species; but it will be noticed that the record of past life is one from the general to the special, and that the earliest organisms belong to generalized types.

XL.—*On the Distribution of the Sclerenchyma of Mettenius in Plants.* By W. R. McNab, M.D., Professor of Botany, Royal College of Science, Ireland.

[Read Monday, March 16, 1874.]

The hard and indurated tissue or sclerenchyma of many plants is familiar to most persons, whether botanical or not. The hard shells or portions of the pericarp of the cocoa-nut, peach, plum, &c., are very well known. There are also, I fancy, few people who have not become acquainted with the sclerenchyma in the pulp of the pear, forming, as it does, the small gritty masses in the ripe fruit. To the entomologist it is also well known, as it occurs in the cork of his cabinet and store boxes, and is fatal to the points of delicate pins.

There are, however, many other examples of sclerenchyma, and to the distribution of sclerenchyma in plants it is now my intention to devote a few minutes' consideration.

The forms of sclerenchyma I have just mentioned are all parenchymatous, being merely thickened and hardened parenchymatous cells. Mettenius observed that prosenchymatous cells also might become hardened and thickened, and that these hardened prosenchymatous cells formed a very important part of the structure of fern-stems. In the stems of many ferns, and particularly in the stems of tree-ferns, bundles of elongated, hardened, and brown-coloured cells exist. These were originally considered to be part of the fibro-vascular bundles, and are even yet described as such by observers at the present day. Van Mohl, however, long ago pointed out that they were not part of the fibro-vascular bundles, while Mettenius still further distinguished them by the name sclerenchyma.

The resemblance between elongated sclerenchyma and bast fibres is so great that in most cases they have been confounded together, and this has led to many mistakes. They possess very many characters in common, and I do not think that they can be distinguished by any optical character, and, as to chemical tests, as far as my own experience goes, they are coloured almost in the same way by iodo-chloride of zinc; the sclerenchyma in most cases becoming slightly more of a pink shade. These optical and chemical characters are, however, of but little importance, and it is the position of the bast fibres that at once enables us to distinguish bast fibres from sclerenchyma. Bast fibres are only met with in the bast portion of the fibro-vascular bundles, the phloem of Naegeli, along with soft bast, or bast parenchyma, and best vessels. The bast fibres may be absent as in Cucurbita, which, however, has a ring of sclerenchyma in the hypoderma; or they may be only very slightly developed, and therefore easily overlooked, as in ferns and equisetums.

Taking the three divisions of the tissues of the embryo as de-

scribed by Hanstein, dematogen, periblem, and plerom, the bast is always part of the plerom-tissues, while the sclerenchyma is chiefly developed in the periblem tissues. I knew, however, at least two instances of sclerenchyma occurring in the plerom, and shall allude to them afterwards.

In vascular cryptogams hardened or sclerenchymatous prosenchyma and parenchyma occur; but the prosenchyma is much more abundant and more generally diffused. In the ferns sclerenchymatous parenchyma occurs commonly in the hypoderma of stem and leaf-stalk, and may be seen in Pteris and in most tree-ferns. Sclerenchymatous prosenchyma occurs very abundantly in ferns, forming either separate bands, as in Pteris, or surrounding, either partially or completely, the fibro-vascular bundles. The sclerenchyma is invariably developed outside the sheath of the fibro-vascular bundles, showing that it is not a part of the bundle.

In Equisetum prosenchymatous sclerenchyma is largely developed, chiefly at the ridges in the stem. It may extend inwards, however, until it reaches the sheath of the fibro-vascular bundles. In this condition it may be very readily mistaken for a portion of the fibro-vascular bundle.

The Ophioglossaceæ have prosenchymatous sclerenchyma surrounding the sheath of the fibro-vascular bundles, as in ferns.

In Marsilea, one of the Rhizocarps, the sclerenchymatous prosenchyma surrounds the fibro-vascular bundle as in the ferns and Ophioglossum, but there is this peculiarity that the ring of sclerenchyma is separated from the sheath of the fibro-vascular bundles by several layers of ordinary parenchyma.

In lycopods the fibro-vascular bundles are in many cases surrounded by a cylinder of sclerenchyma.

Passing to the Archisperms parenchymatous sclerenchyma is found to be abundant in Cycadaceæ, Coniferæ, and Gnetaceæ. It is abundant in the petiole of Zamia tridenta, and also under the epidermis of the leaf. In the stem and leaf of Cycas revoluta it is also well marked. It is well developed in the leaves of many pines, as in Pinus sylvestis, strobus, and pinaster, and also in the leaves of species of Cupressus. In Welwitschia the sclerenchyma is very largely developed, in the stem, leaf, and in the bracts.

Passing to the Monocotyledons, we find that in them parenchymatous sclerenchyma is largely developed. I shall merely give a few examples:—petiole of canna indica, under epidermis; stem of Cyperus, under epidermis; Lilium martagon, under epidermis; leaf of Pandanus odoratus, in scattered groups, leaf of Stipa plumosa. In Phormium tenax the sclerenchyma is largely developed, and forms a large percentage of the phormium fibre, which if it were like ordinary flax would consist exclusively of bast fibres.

In Dicotyledons I have not noticed sclerenchyma to be so abundant as in the other groups. Parenchymatous sclerenchyma occurs under the epidermis of young stems of Clematis vitalba. Parenchymatus scle-

renchyma in the periblem-tissues seems common. In Corylus avellana it occurs under the corky periderm, while in cork and in pears the parenchymatous sclerenchyma belongs to the periblem-tissues. Two examples of parenchymatous sclerenchyma in the perom tissues have occurred to me. In Hoya carnosa, in the pith, and in the Victor's laurel, Laurus nobilis, the groups of hardened parenchyma alternate in the bast portion of the bundle with the bast fibres. This is the most curious example I have yet met with. Lastly, in Cucurbita no bast fibres exist in the phloem portion of the bundle, but a zone of sclerenchyma exists in the hypoderma.

In illustration of his remarks Professor McNab exhibited the following objects with the oxy-hydrogen microscope:

1. Tranverse section of Pteris aquilina, sclerenchyma in separate bundles, and partially or completely investing the fibro-vascular bundles.
2. Transverse section of Equisetum hyemale, sclerenchyma at the angles of the stem.
3. Transverse section of South American Equisetum. The sclerenchyma was in large dark-coloured masses, running from the epidermis to the sheath of the fibro-vascular bundles.
4. Transverse section of the petiole of Zamia tridenta. The sclerenchyma forming very numerous small bundles in the hypoderma.
5. Section of leaf of Cycas revoluta, with sclerenchymatous cells under epidermis.
6. Welwitschia mirabilis, transverse section, with sclerenchymatous parenchyma in the hypoderma.
7. Transverse section of petiole of Canna indica, with sclerenchyma in hypoderma.
8. Transverse section of stem of Hoya carnosa, sclerenchymatous parenchyma in the pith.
9. Cucurbita Pepo, transverse section of stem, no bast fibres in the fibro-vascular bundles, but with sclerenchyma in the hypoderma.
10. Laurus nobilis, transverse section, parenchymatous sclerenchyma alternately with groups of bast fibres in the phloem of the fibro-vascular bundles.

XLI.—*Return of Donations to the Royal Dublin Society.*

BOTANIC GARDENS.

W. J. Kent, Esq., 51, *Rutland-square* :—15 kinds of Seeds, from Ceylon.

Dr. Barry, 10, *Colville-road, Nottinghill* :—2 Tree Ferns, from Australia.

Captain Gardiner, *Mullingar Barracks* :—Parcel of Mixed Indian Seeds.

The Messrs. Veitch, *Exotic Nursery, King's-road, Chelsea* :—12 very rare and valuable Plants.

Mrs. Gregory, *Coole Park, Gort, Co. Galway* :—36 kinds of Seeds, from Ceylon.

Dr. Schomburgh, *Director, Botanic Garden, Adelaide, Queensland, Australia* :—50 kinds of rare Seeds.

Major-General the Right Hon. Sir Thomas Larcom, K. C. B., *Heathfield House, Fareham, Hants* :—Parcel of Seeds from China.

Dr. Richardson, *Ely-place, Dublin* :—2 kinds of Seeds.

Lady Dorothy Neville, *Dangstein, Petersfield, Hampshire* :—27 kinds of rare and valuable Plants.

Messrs. Jackson, *Nurserymen, Kingston-on-Thames* :—17 kinds of rare Plants.

The Rev. H. Ellicombe, *Rectory, Bitton, near Bristol* :—23 kinds of rare Plants.

Mr. Latham, *Botanic Gardens, Edgebaston, Birmingham* :—17 kinds of rare Plants.

Mr. Johnston, *Botanic Gardens, Belfast* :—Basket full of Verbenas, Pelargoniums, and other Bedding-out Plants.

Dr. Haughton, *Trinity College, Dublin* :—Packet of Seeds of *Cordylin-australis*, which ripened in Co. Wexford.

Edward Hodgson, Esq. (of Hodgson and M'Master), 124, *Capel-street, Dublin* :—110 kinds of Seeds, from Australia.

Captain Henderson, 107th Regiment, *Wellington Depôt, Neilghery Hills, India* :—3 small cases with living Ferns.

Dr. Hooker, *Royal Gardens, Kew*:—95 packets of Seeds.

Professor Decaisne, *Museum, d'Histoire Naturelle, Paris*:—157 kinds of Seeds.

Herr Ortgies, *Inspector, Botanic Garden, Zurich*:—27 kinds of Seeds.

John Tyreman, Esq., *Penlee, Trecony, Cornwall*:—26 kinds of Seeds.

Professor Dyer, *Royal Horticultural Society, London*:—49 kinds of Seeds.

Dr. Reichenbach, *Director, Botanic Garden, Hamburgh*:—75 kinds of Seeds.

James M'Nab, Esq., *Royal Botanic Garden, Edinburgh*:—5 kinds of Seeds of rare Plants.

Signor Augustinus Todaro, *Director, Botanic Garden, Palermo, Sicily*:—199 kinds of Seeds.

Dr. Schomburgh, *Director, Botanic Garden, Adelaide, Australia*:—63 kinds of Seeds.

Augustinus Todaro, *Palermo*:—89 kinds of Seeds (2nd lot).

P. A. O'Shaunesy, Esq., *Rockhampton, Australia*:—15 kinds ot Seeds, and some interesting articles for Botanical Museum.

Charles Moore, Esq., *Director, Botanic Garden, Sydney, N. S. W.*:—59 kinds of Seeds.

Dr. Caspary, *Director, Botanic Garden, Königsberg, Prussia*:—66 kinds of Seeds.

Dr. Hooker, *Royal Garden, Kew*:—Plant of *Victoria Regia.*

Mrs. Rait, 5, *Mountjoy-place, Dublin*:—2 kinds of Seeds.

E. Wilson, Esq., *Mountjoy-square*:—2 kinds of dried Ferns, from St. Helena.

Charles Moore, Esq., *Director, Botanic Garden, Sydney, N. S. W.*:—3 packages of Palm Seeds; 1 do. of Musa ensette.

Mitchell Henry, Esq., M. P., through A. Armstrong, Esq., *St. Andrews, Milltown*:—26 packages of rare Seeds.

Surgeon-Major Thornton, 109*th Regiment, India*:—Box of mixed Seeds.

Mitchell Henry, Esq., M. P. :—2 packets of Seeds.

Henry Roe, Esq., *Mountainview, Dundrum*:—Fine male inflorescence of *Ercephalantus villosus*, for Museum (very rare).

Sir F. Brady, Bart., M. R. D. S. :—2 packages of Seeds.

Professor SURRINGAR, *Director, Botanic Garden, Leyden, Holland*:—33 young Palms, and 4 other rare Plants.

GEORGE MAW, Esq., *Benthal Hall, Broseley, Shropshire*:—10 rare Alpine Plants.

JAMES M'NAB, Esq., *Curator, Botanic Garden, Edinburgh*:—36 rare Plants.

C. MOORE, Esq., *Director, Botanic Garden, Sydney, N. S. W.*:—Hardian Case filled with rare Plants.

J. HOPE, Esq., through E. and W. Hackett, *Seedsmen, &c., Adelaide, Australia*:—Parcel of Seeds.

Horr BOUCHE, *Inspector, Botanischer Garten, Berlin*:—40 packages of Seeds.

Surgeon-Major THORNTON, *109th Regiment, India*:—64 packages of Seeds.

Professor CARRUEL, *Director, Botanic Garden, Pisa, Italy*:—A very valuable collection of Italian terrestrial *Orchidaceæ*.

Dr. HOOKER, *Director, Royal Gardens, Kew*:—43 very rare Plants, including several Palms.

Mr. BAXTER, *Botanic Gardens, Oxford*:—30 kinds of rare Plants.

Mr. KEIT, *Curator, Botanic Garden, Natal*:—Large case with 4 splendid stems of rare Fern Trees (very important).

Dr. JAMESON, *Director, Botanic Garden, Saharumpore*:—40 packages of Indian Seeds.

A. M'CLINTOCK, Esq., *Buenos Ayres*:—2 packages of Seeds.

November 1st, 1874. D. MOORE, *Director*.

NATURAL HISTORY MUSEUM.

R. W. COTTON, Esq., *The Hall, Lismore*:—2 specimens of the Twaite Shad (*Alosa finta*), from Lismore, Waterford, forwarded at the request of Colonel Gaisford.

FFRENCH MAC DERMOTT, Esq., *Armagh House, Ballyfarnan, Roscommon*:—2 Assegais, and a War Hatchet, used by the native tribes in South Africa.

W. FRAZER, Esq., M. D., *Harcourt-street*:—A few Chameleon's Eggs from India.

Mrs. BATTERSBY, *Cromlyn, Rathowen, Westmeath*:—Specimens of the Elephant Hawk Moth (*Chærocampa elpenor*), taken at Cromlyn.

Hon. LUKE G. DILLON, *Clonbrock, Galway*:—Nests and Insects of four species of Trapdoor Spiders, collected at Mentone and Bordighera.

VALENTINE BALL, Esq., 43, *Wellington-place, Leeson-street*:—Skins of several species of Mammalia, and of a Porcupine Fish, from India.

Dr. JOHNSTON, *Rotundo Hospital*:—Three pieces of Polynesian Cloth.

Rev. B. ADAMS, D. D., *Cloghran Rectory, Drumcondra*:—A Shrew Mouse (*Sorex pygmæus*).

THOMAS H. O'DELL, Esq., 53, *Upper Leeson-street*:—A duck-billed Platypus (*Ornithorhynchus paradoxus*).

Rev. EDWARD POTTERTON, *Kilmore Rectory, Belmullet*:—Part of the palate-bone of a Razorback Whale (*Balænoptera Musculus*), which had been cast ashore on the Mullet, Mayo.

Mr. THOMAS J. REILLY, *Belmullet, Mayo*:—Three pieces of baleen from the Whale which had been stranded on the Mullet.

J. T. TISDALL, Esq., *Rathcoole, Dunleer, Louth*:—A white specimen of the spotted Flycatcher (*Muscicapa grisola*).

FRANCIS COLGAN, Esq., *Cappagh, Enfield, Kildare*:—A Rabbit, with elongated front teeth.

W. LITTLE, Esq., *Iceland, Ballina*:—A remarkably large specimen of the Grey Skate (*Raia batis*); and a tentacle from a very large Cuttle Fish (*Omneastredhes sagittatus*).

Mrs. E. WALLER, *Aughnacloy, Tyrone*:—A large series of rare British Shells, collected by the late Mr. Edward Waller, during his numerous dredging expeditions on various parts of the British coasts, and specimens of the rare *Echinoderms, Cidaris papillata,* and *Spatangus meridionalis.*

ROYAL ZOOLOGICAL SOCIETY OF IRELAND:—Photograph of the Elephant "Prince," taken from life.

Captain DOVER, *Castle Connor, Ballina*:—Specimens of *Ianthina communis* with the float attached, collected on the coast of Donegal.

Sir F. L. M'CLINTOCK, *H. M. Dockyard, Portsmouth*:—A black Rat (*Mus rattus*), taken in the Dockyard at Portsmouth.

Sir VICTOR BROOKE, Bart., *Brookeborough, Fermanagh*:—A golden Eagle (*Aquila chrysaetos*); a pine Marten (*Mustela abietum*); 2 Grey-leg Wild Geese (*Anser ferus*); and a few other specimens.

A. F. Wright, 2, *Clyde-road*:—A series of specimens, viz., Cocoons of Silk Worm, Raw Yellow Silk, White Bleached Silk, three shades of Black Silk, and Cotton Yarns, white and dyed; all to illustrate the manufacture of Plush, used for making Silk Hats.

Edwin Birchall, Esq., *Infirmary, Leeds*:—A Bank Vole (*Arvicola riparia*), taken near Leeds.

Rev. H. Croly, *Poulathomas, Bangor, Mayo*:—The Skull of a Young Seal (*Phoca vitulina*).

Right Hon. Lord Lisgar, *The Castle, Bailieborough*:—A large Collection of dried Ferns, from the Solomon Islands, and other localities in the Southern Hemisphere.

T. F. Brady, Esq., *Inspector of Fisheries*, 12, *Ely-place*:—A vertebra from the backbone of a Basking Shark (*Selachus maximus*), killed off Inishbofin, Mayo.

Captain Freeborn, *1st Regiment of Foot*:—Head and Horns of the Ammon Wild Sheep (*Ovis ammonoides*), and Head and Horns of a Burrhel (*Pseudois nahoor*), both shot in Thibet.

Mrs. M'Nab, *Royal Botanic Garden, Edinburgh*, per Professor W. R. M'Nab:—A Collection of Indian Birds' Skins, from Darjeeling; also a number of Birds' Skins from Seharumpore, collected by Mr. W. Bell.

Miss Waller, 63, *Wellington-road*:—2 Emex's Eggs and 2 Nests of Weaver Birds.

Rev. W. Hickey, P.P., *Queenstown, Co. Cork*, per Miss Carroll, 59, *Upper Mount-street*:—A specimen of *Sphæria Robertsii*, from New Zealand.

Captain T. W. Freeman, *S. S. Winconsin*, per Robert H. Scott, Esq., F. R. S., *Meteorological Office*, 116, *Victoria-street, London, S. W.*:—A specimen of *Scopelus Humboldti*, taken in the North Atlantic.

Lieutenant J. C. Thomas, R.N., *H. M. S. Vanguard, Kingstown*:—The palate of a large Ray, captured off the east coast of Australia.

Right Hon. Lord Ventry, *Kildare-street Club*:—A fine stuffed specimen of the British Wild Cat, from Ross-shire, N. B. [Deposited].

Miss King, *Rathfeston, Tullamore*:—A Cream-coloured Rook, shot at Rathfeston.

Alfred Ruttledge, Esq., *14th Regiment*, 3, *Fitzwilliam-place*:—A stuffed specimen of *Hydromys chrysogaster*.

(Signed) Alexander Carte, M.D., F.L.S., *Director*.

June 3, 1874.

FINE ARTS.

Mrs. MARIA WATKINS, 1, *Beechwood-road, Cullenswood, Co. Dublin*:—
A Collection of Casts of the Works of her late husband, JOSEPH WATKINS, R. H. A., sometime a Student of the School of Art, consisting of the following:—Lord O'Hagan; Sir Bernard Burke; Bishop of Peterborough; Sir George Hodson; Hon. John Cole; late General Colomb; late Professor Jukes; late Professor Sullivan; late Rev. —— Pollock; late Dr. Mayne; Lady Hodson; Master Hodson; Miss Trench; Star of Hope; late Mrs. Jellett; late Miss West; late Mr. Brooke; late Mr. Mulvany; Master Flood; Rev. Dr. Bailey.

INTELLIGENCE.

SCHOOL OF ART.

DISTRIBUTION OF PRIZES TO THE ART STUDENTS.

THE annual distribution of Prizes to the Students of the School of Art took place in the Lecture Theatre on the evening of Friday, the 20th February, 1874.

HIS EXCELLENCY EARL SPENCER, LORD LIEUTENANT, took the Chair.

His Excellency was accompanied by the Countess Spencer, the Dowager Countess Spencer, the Earl of Antrim and the Dowager Countess of Antrim, Lord Edward Cavendish, Private Secretary to His Excellency, and the Hon. Colonel Caulfeild, and was received by the Vice-Presidents, Council, and Fine Arts Committee and Officers of the Society.

GEORGE JOHNSTONE STONEY, A.M., F.R.S., one of the Hon. Secretaries of the Society, addressing His Excellency and those present, observed that in these days the desire and anxiety to co-operate for any worthy purpose which stood upon common ground, increased, and the duties to which the Society, under whose auspices they were assembled, were devoted, belonged to that category. Industry was neither Protestant nor Catholic; science was neither Whig nor Tory; art was ablè to flourish in heathen Greece and in Christian Rome, under the autocratic Government of Spain, and under the freer institutions of Holland. In that room, then, they had nothing to do with the great political struggle which had just concluded. But he might be allowed to express one feeling in which men of all political sentiments in that Society concurred, and that was a feeling of regret that one of its consequences was to withdraw His Excellency from their midst. They trusted that, if the motion of the political machine should again bring up that portion of the wheel which now stood low, His Excellency would be found willing to assume again the high office in which he had displayed amongst them for five years the highest qualities of a man. Turning to the special programme of the evening, they were assembled to distribute the prizes which had been won by their Students in their work during the session which ended in April last; and, in referring to that work, it was his pleasing duty to renew those oft-repeated pæans over their success in the School of Art of the Royal Dublin Society. He would therefore dwell but very briefly upon these gratifying successes. The long list of prizes to be conferred, no less than 47 of which were prizes of the highest grade, would of itself indicate their success; but it would be brought out still more closely by instituting a comparison between that School of Art and the four other principal Schools in connexion with South Kensington—Glasgow, which was the largest; Birmingham, which came next in point of numbers; Edinburgh, which stood almost equal with the Dublin School; and that of Manchester, which came last. Making a comparison of prizes won in these Schools, it would be found that in Glasgow awards had been made to one Student out of 53; in Birmingham, to one out of 26; and in Dublin, to one out of every 8; and that discrepancy was not affected by the discrepancy of numbers already mentioned. This proved what great ends might be accomplished with larger Schools, larger means, and, above all, with the assistance of a local Art Museum. As it was, they had no bad display, thanks to the aptitude of the pupils, to the increasing exertions

of the Master, Mr. Lyne, and of Miss Julyan, and of the Committee—the skilled Committee which overlooked all. Many students possessed of great ability had during the past year, from various causes, left the city—some to enter upon the practice and study of art in the metropolis of England, amongst whom he might mention Mr. Robert Catterson Smith, who had obtained an engagement with Mr. Foley, the eminent sculptor, and Mr. Edward Gibson, both of whom evinced wonderful talent in the statuettes produced for the Champion Athletic Club last year. Other names occurring to him as those of Students now honourably engaged in the practice of art in the metropolis were—Messrs. Francis Walker, Wm. Perry, M. Yeates, C. Bailey, E. Ryder, S. Barry, A. Parkinson, &c. There still remained however many who evinced marked aptitude and ability, such as might lead to distinction, among whom he would respectfully refer to Miss M. A. Morgan, Miss A. Parnell, Mr. J. T. Mills, Miss E. Maylor, Mr. J. Kavanagh, Miss Weld, Miss O. Poole, Mr. T. Parkes, Mr. H. S. Mercer, Miss F. Brett, Miss K. O. Brian, L. F. Jordan, M. Irwin, E. Irwin, S. Reilly, Mrs. J. D. Tobias, Mr. H. Hall, Miss J. Benson, Mr. F. Gernon, Miss P. A. Moss, Miss M. D. Webb, Mr. J. C. Boyce, Mr. G. B. LeFanu, and Miss S. Purcer. It was gratifying to find that very many of their Students who entered upon art pursuits in this and other countries remembered with gratitude the valuable instruction they had received in those Schools. In conclusion, he thanked His Excellency for the great interest he had evinced in their work, as evidenced by his patronage and presence at their annual *reunions*, and by his loan to the National Gallery of several valuable paintings of the old school, for the study of which Students gained so much distinction.

Lieut.-Colonel Adamson, Chairman of the Committee of Fine Arts, said it now became his duty to submit the report of the Head Master of the Schools, and he might mention, in the first instance, that they were able to refer with great pleasure to their success in the national competition of the United Kingdom. The report alluded to "the success achieved in the national and other competitions during the year." Such success—the result of much earnest and well-directed labour, and of the highest development of an educational art system that has hitherto been attained in this country—is especially encouraging since the successful teaching of art appeared to be for many years an experiment and a problem. The works in drawing, painting, modelling, &c., were forwarded to London in April last. The total number of such studies amounted to 893, as compared with 581 similar works forwarded in 1872. The number of national awards obtained on the last occasion amounting to nine, places us in a most favourable position when compared with the most considerable of the Art Schools of the United Kingdom. The successful national competitors were—Miss M. Irwin, Miss F. L. Jordan, Mr. E. Gibson, Miss C. Barnes, Miss H. Thornhill, Miss I. L. Backnell, Mr. H. S. Mercer, Miss E. Naylor, H. Everth. The number of works for this competition amounted to 74—a greater number than on any previous occasion. The examiners report on the evident progress and increased activity of the school, and of the improvement observable in all the works, and they are of opinion that the objects for which the schools were established, viz., the promotion of Art (decorative and pictorial) in Ireland are largely benefited by it. They also state that the designs for various specific manufactures are of remarkable merit. To those works, competing for prizes of the third or highest grade, thirty-eight students succeeded in obtaining forty-seven awards, a number much greater than has on any former occasion been

obtained. The appended tables show the position occupied by the Society's Schools, as compared with the four most considerable Art Schools of the United Kingdom, as regards the obtaining of the prizes of the third or highest grade, and national awards and third grade prizes in proportion to the number under instruction:—Third or highest grade prizes—Dublin, 47 prizes to 38 students; Edinburgh, 27 students; Glasgow, 18 students; Birmingham, 41 students; Manchester, 13 students. National awards and prizes of the highest grade—Dublin, 1 for every 8 students taught; Edinburgh, 1 for every 14; Glasgow, 1 for every 53; Birmingham, 1 for every 26; Manchester, 1 for every 17. The adjudication of the medals offered by the Royal Dublin Society in the various subjects of study took place on the 20th December, when Sir George Hodson, Bart.; Thomas A. Jones, Esq., P.R.H.A.; A. Burke, Esq., R.H.A.; Thomas Drew, Esq., R.H.A., acted as judges, and were assisted by T. S. Millar, Esq., and W. Fleming, Esq., manufacturers. In the forthcoming London International Exhibition a space will be devoted in the Fine Art Galleries to the exhibition of works of industrial art, designed or executed by those who have been or are now students of the Art Schools of the United Kingdom, with the view of bringing prominently before the public the beneficial influence of the schools on the production of fine art manufactures. His Excellency was aware, Colonel Adamson continued to say, that the Schools of Art and Design had been in existence and in working order in Dublin for about 130 years, but it was not until the year 1851 that the Government thought it necessary to establish Schools of Art throughout the country. The establishment of those schools had done much to remedy the wants formerly experienced, and indeed they were benefiting almost every class of society; they were finding their way amongst the masses of the people, and benefiting almost every trade. It had been stated upon most excellent authority that the students who were engaged in these pursuits were generally well conducted, gentle, and happy--and such pursuits had such a tendency. There was one subject which had been touched upon by Mr. Stoney, and to which he wished to add a few facts. Mr. Stoney had alluded to the serious want of a museum of ornamental art. It was absolutely necessary for the welfare of their School that they should obtain such a museum. He feared, however, that they could not do this without the assistance of the Chancellor of the Exchequer. They were well aware that in this matter they did not want his Excellency's interposition in their favour. They also hoped to derive some advantage from what was known as the Taylor Fund—a sum of money which, fourteen or fifteen years ago, was left by a gentleman of that name for the furtherance of Art in Ireland, but from which, in consequence of the law's delays, they were yet without receiving benefit. He wished further to state that a most impartial and favourable testimony had been borne by the highest authorities in England to the successful working of their Schools. It would be out of place in an assemblage such as the present to make any political allusion, but he could say that since his Excellency came to this country as Chief Governor he had ever extended to the Royal Dublin Society, and this department in particular, his kindest favour. They could never forget it. He would not presume for himself to make these observations, but he represented a very large constituency that night, and he knew they thoroughly appreciated the statement made by Mr. Stoney of the esteem, respect, and affection which were entertained towards his Excellency personally, and towards the gracious lady who brightened their assembly that night.

REPORT OF THE HEAD MASTER OF THE SCHOOLS OF ART OF THE ROYAL DUBLIN SOCIETY, 1873.

To the Chairman and Committee of Fine Arts.

GENTLEMEN,—I beg to lay before you my Report of the operations of the Schools of Art of the Royal Dublin Society for the year 1873, and it is gratifying to have to speak of their continued prosperity, and to be able to refer to their success in the National and other competitions during the year.

The works in drawing, painting, modelling, &c., representing nearly every stage of art instruction, were forwarded to London in April last.

The total number of such studies amounted to 893, as compared with 581 similar works forwarded in 1872.

It was found impossible to retain for transmission to London many works of merit, from various causes.

The number of National awards obtained on the last occasion, amounting to nine, places us in a most favourable position when compared with the most considerable of the Art Schools of the United Kingdom.

The number of works selected for the National Competition amounted to seventy-four, a greater number than on any previous occasion.

The examiners of such works in National Competition were:—C. W. Cope, R.A., R. Redgrave, R.A., F. R. Pickersgill, R.A., H. Weeks, R.A., J. C. Horsley, R.A., Owen Jones, esq., and H. A. Bowler, esq.

These gentlemen report on the evident progress and increased activity of the school, and of the improvement observable in all the works, and they are of opinion that the objects for which the schools were established, viz., the promotion of Art (decorative and pictorial) in Ireland are largely benefited by it. They also state that the designs for various specific manufactures are of remarkable merit.

To those works competing for prizes of the third or highest grade, 38 students succeeded in obtaining forty-seven awards, a number much greater than has on any former occasion been obtained. And I may mention that the South Kensington School obtained thirty-seven of such awards in 1872.

The appended Tables show the position occupied by the Society's Schools, as compared with the four most considerable Art Schools of the United Kingdom, as regards the obtaining of the prizes of the 3rd or highest grade, and National awards and 3rd grade prizes in proportion to the number under instruction:—

	3rd or Highest Grade Prizes.
Dublin, ...	47 Prizes to 38 students.
Edinburgh, ...	– „ 27 „
Glasgow, ...	– „ 18 „
Birmingham, ...	– „ 41 „
Manchester, ...	– „ 13 „

	National Awards and Prizes of the Highest Grade.
Dublin, ...	1 for every 8 students taught.
Edinburgh, ...	1 „ 14 „
Glasgow, ...	1 „ 53 „
Birmingham, . . .	1 „ 26 „
Manchester, ...	1 „ 17 „

The adjudication of those medals offered by the Royal Dublin Society in the various subjects of study took place on the 20th December, when Sir George Hodson, bart., Thomas A. Jones, esq., P.R.H.A., A. Burke, esq., R.H.A., Thomas Drew, esq., R.H.A., acted as judges, and were assisted by J. S. Millar, esq., and W. Fleming, esq., manufacturers.

An Examination in Freehand Drawing, Geometrical Drawing, Perspective and Model Drawing, took place in the School of Art, on the evenings of the 1st and 2nd of May last.

The following gentlemen, members of the Council, and of the Fine Arts Committee, attended:—Lieutenant-Colonel Adamson, Dr. Evory Kennedy, Thomas A. Jones, esq., P.R.H.A., John Du Bedat, William Berry, David Routledge, E. H. Kinahan, F. R. Davis, K.J.J., esquires; also Major Papillon, R.E.

Upon that occasion 70 students succeeded in passing an examination in 97 papers.

The appended table shows the relative success by male and female students:—

By Male Students.

	Freehand.	Geometry.	Perspective.	Model Drawing.	Total.
Passed,	19	5	7	11	42
Excellent,	2	2	2	3	9
Totals,	21	7	9	14	51

By Female Students.

	Freehand.	Geometry.	Perspective.	Model Drawing.	Total.
Passed,	17	8	6	11	42
Excellent,	1	0	1	2	4
Totals,	18	8	7	13	46

The following students distinguished themselves in the examination:—Robert D. O'Brien, Mary Montgomery, Fredricka Douglas, and Alexander Brown.

The examination of those pupils of external schools in Dublin in which Drawing Classes are established took place in the School of Art on the evening of 27th May, when Four Bronze Medals and Eight Certificates were awarded for success in a time exercise in Freehand Drawing.

At the conclusion of a course of lectures on Artistic Anatomy, Dr. Alexander M'Allister held an examination in that subject. Thirteen students of our schools presented themselves, and Two Silver Medals were gained by M. D. Webb and Olivia Poole.

An exhibition (the most considerable yet held in this country) of students' works was open in the Schools of Art during the Christmas vacation, and was visited by 5,480 persons. This display was inaugurated by His Excellency the Lord Lieutenant and the Countess Spencer.

It is much to be regretted that we have not in connexion with our schools a special gallery for exhibitional purposes, and in which could be displayed permanently a collection of selected studies, as executed in our schools, such as would prove both instructive to students of Art and interesting to the general public.

A series of 112 works exemplifying the course of Art Education, as pursued in the Society's schools, were on view in the recent Exhibition of Art Treasures in the Industrial Exhibition Palace. A list of such studies, &c., will be found in the Appendix to this Report.

The number of those Drawing Classes in and about Dublin receiving instruction through the agency of the central school is steadily increasing, and applications for teachers qualified to instruct such classes in Elementary Drawing become more numerous.

During the past year the number of students attending the School has been 452, of which number 222 were males and 230 females.

The total number of artisan students attending amounted to 274, of which number 215 were males and 59 females.

The total amount of fees was £486 11*s.* 2*d.*

The maximum of attendance took place in the month of March, and was smallest in the month of July.

The total number of attendances during the year has been 25,901.

I have to acknowledge the valuable assistance rendered by Miss Mary Julyan, in the instruction of the female classes.

My thanks are also due to my assistants, Mr. Edmond Ribton Byrne, Mr. William H. Murray, Mr. Robert Walsh, and Miss M. A. M'Gee.

In conclusion, I may remark that Art Schools generally, during the brief period of their existence have, in their constant endeavour to promulgate true principles and to develop inventive talent and adaptive ingenuity, had serious difficulties to contend with and overcome, especially those arising from a perverted public taste.

Their teaching, however, has prevailed to such an extent, that the improved taste, now apparent throughout the country, may be chiefly traced to their action.

The utility of such establishments as aids to the various requirements of manufacture and the advancement of Art in all its branches, or the advantages resulting from such a relation between Art and Industry it is needless to enlarge upon.

It is encouraging to find that our efforts to inculcate just ideas and principles, necessary for the successful practice of Art and its due promotion in this country, are every day becoming better understood and appreciated.

The Schools of this Society would doubtless be greatly benefited by the possession within their own walls, and convenient for ready reference, of a well considered selection of objects of Art Workmanship of various countries and periods, and especially of Pottery and Textile fabrics.

A collection of such objects, not necessarily large, but representative of the particular and leading characteristics of the various styles, would prove of the greatest value.

I have the honour to remain, gentlemen, your obedient servant,

R. Edwin Lyne, Head Master.

Loans from the Department of Science and Art during the year.

Life Study by Mulready (Red Chalk).
Glass Case, containing twenty-six objects for study.
Art Industries at South Kensington, two parts (stiched).
Official Reports of the International Exhibition of London, 1871, 2 Vols.
Landscape in Holland, by Van Goyen (Oil).
Bunch of Flowers, with Butterfly, by Rachel Ruyche (Oil).
"Hove down to Careen," by T. Jacobs (Oil).
Study of a Hand placed against a green mossy wall, Michael Mulready (Oil).
Head of an Old Lady, by Sir Thomas Lawrence (Oil).
Study of nude Male Figure, stumped, by Lefebrie.
Entrance to the Castle of Dieppe, sepia, by Cotman.
The Bridle Road, by C. C. Pyne (Water Colour).
The Fairford Windows, by the Rev. James Gerald Joyce. 1 Vol.
Architecture of Ancient Delhi, illustrated with photographs, by Lieutenant Henry Hardy Cole, R.E.
Six Lithographic Examples of French Relief Ornament.
View on the River Maas, Holland, by A. Stork (Oil).
Studies of Nude Figure, by Maclise (Chalk).
Studies of Sheep's Heads by George Morland.
Branch of Apples in Water Colours (unknown).

His Excellency then distributed the prizes to the successful students, who were each called up according to the following list, and had the gratification of receiving their prizes at His Excellency's hands;—

[Awards.

AWARDS OF JUDGES IN THE VARIOUS COMPETITIONS OF THE YEAR 1873.

NATIONAL COMPETITION, 1873.

AWARDS to STUDENTS of the SOCIETY'S SCHOOL of ART by the Judges appointed by the Department of Science and Art, London.

Name.	Stage.	Description of Work.	Award.
Irwin, Miss Marcella,	23*c*	Design for Lace, . . .	Silver Medal.
Jordan, Miss F. L.	23*c*	Do. do. . . .	do.
Gibson, Mr. Edward,	19*d*	Model of Head in relief (Life), .	do.
Barnes, Miss Clara,	9*a*	Anatomical Study, . . .	Bronze Medal.
Thornhill, Miss H.M.	9*a*	Do. do. . . .	do.
Bucknall, Miss I. L.	23*c*	Design for Wall-paper, . .	Queen's Prize.
Mercer, Mr. H. S. .	19*b*	Model of Head (Juno), . .	do.
Naylor, Miss Elizab.	8*b*1	Chalk drawing (dying Alexander),	do.
Everth, Miss H. .	15*a*	Group of Still-life, in Oil, .	do.

LIST of STUDENTS to whom THIRD GRADE PRIZES have been awarded.

Name.	Prize.	Stage.	No. of Works.	Subject.
Boyle, Mr. J. T. .	P 2	23*c*	1	Original Design for a Plate.
Bucknall, Miss I. L.	"	5*a*	1	Group of Models Shaded in Chalk.
Bredin, Miss M. A. .	"	9*a*	1	Anatomical Studies in Water Colors.
Birch, Miss B. .	"	22*c*	1	Elementary Design to fill Cinquefoils.
Hanrahan, Mr. J. .	"	23*c*	1	Original Design for Table Damask.
Irwin, Miss E. E. .	"	23*c*	2	Original Design for Lace (Brussels, Point, and Guipure).
Irwin, Miss M. .	"	23*c*	2	Original Design for Lace (Honiton and Guipure).
Kavenagh, Mr. J. .	"	23*d* & 23*c*	2	Original Design for a Chimney Breast. Original Design for Carpet.
Kerr, Miss E. .	"	15*a*, 5*b*	2	Group (Still Life in Water Colors). Egg-plant, portion of the Architrave of the Gates of Ghiberti, Shaded in Chalk from the Round.
Magee, Miss M. A.	"	23*c*	1	Original Design for a Floor Cloth.
M'Gee, Miss M. A.	"	15*a*	1	Group (Still Life in Water Colors).
Murray, Mr. W. H.	"	23*c*	1	Original Design for an Ecclesiastical Carpet.

LIST of STUDENTS to whom THIRD GRADE PRIZES have been awarded—*continued.*

Name.	Prize.	Stage.	No. of Works.	Subject.
Miles, Mr. J. T.	P 2	23*d*, 23*c*	2	Original Design for Chimney Breast. Original Design for a Carpet.
Mitchinson, Miss C.	"	23*c*	1	Original for Muslin Dresses.
Naylor, Miss E. H.	"	5*b*	1	Egg-plant, portion of the Architrave of the Gates of Ghiberti, Shaded in Chalk.
O'Cleary, Miss L. M. M.	"	23*c*	1	Original Design for Table Damask.
Wallace, Miss E.	"	14*a*	1	Flowers from Nature in Water Colors. Byonia.
Walsh, Mr. R. F.	"	23*c*	1	Original Design for Figured Damask.
Arnold, Miss E. M.	"	8*b*(2)	1	Study from the Antique of the Discobolus in Chalk.
Ball, Miss S. P.	"	23*c*	2	Two Original Designs for Furniture Damask.
Campbell, Miss I.	"	5*a*	1	Group of Models Shaded in Chalk.
Jordan, Miss F. L.	"	23*c*	3	Original Design for Poplin Dress. Original Design for Floor Cloth. Original Design for Furniture Poplin.
Lee, Miss Nannie.	"	14*a*	1	Flowers from Nature in Water Colors.
McSorley, Miss M. E.	"	10*a*	1	Foliage from Nature in Outline.
Poole, Miss O. E.	"	8*b*(2)	1	Discobolus from the Antique in Chalk.
Thornhill, Miss H. A. M.	"	14*a*	1	Flowers from Nature in Water Colors.
Bradley, Miss D.	P 1	4*b*	1	Ornament Shaded from the Flat, Chalk (Ivy Column).
Campbell, Miss I.	P 2	2*b*, 23*c*	2	Tarsia enlarged, in Outline.
Palmer, Miss A.	P 1	2*b*	1	Original Design for Table Damask.
Cochrane, Miss M.	P 1	4*b*	1	Tarsia enlarged, in Outline. Ornament from a Church in Rome, by Sansovino.
Ffolliott, Miss A.	P 2	5*a*	1	Group in Chalk from the Round.
Martin, Miss M.	P 2	14*a*	1	Flowers from Nature in Water Colors.
Weld, Miss M.	P 2	15*a*	1	Still Life Group in Oil.
Byng, Miss E. N.	P 1	4*b*	1	Gothic Cup Shaded in Chalk.
Corbett, Mr. L.	P 2	10*a*	1	Foliage in Outline from Nature.
Walker, Miss Jeanie,	P 1	4*b*	1	Part of Antique Pilaster, Roman.
Smith, Mr. G. G. P.	P 1	6*a*	1	Farnese Hercules enlarged (outline).
Smith, Mr. R. C.	P 2	19*b*	1	Statuette from Antique (Jason).

REPORT OF JUDGES APPOINTED TO EXAMINE THE WORKS OF THE STUDENTS IN THE ART SCHOOLS, ROYAL DUBLIN SOCIETY, DECEMBER 20TH, 1873.

WE have, on this day, carefully examined the works submitted for our inspection by the pupils of the Art Schools, and in the consideration of the designs for manufactures and textile fabrics we have been assisted by the advice of Mr. Millar, of the firm of Millar and Beatty of this city, and of Mr. Fleming, from a house of much repute at Halifax, in Yorkshire, and also of Dawson-street, in this city.

The display is, upon the whole, highly creditable, although some of the classes are not so fully represented as heretofore.

In Class III., composed of studies of still-life, groups, &c., in oil and water colours, there is a large and very attractive display, bearing evidence of very attentive study, a close observance of natural effects, skilful handling, and artistic feeling. We cannot, however, avoid expressing our opinion that possibly an undue degree of importance may attach to this branch of study which does not practically lead to professional distinction or to remunerative results.

In the Designs, Class VI., for Textile Fabrics and Wall Decoration the competition is more limited than heretofore. This may partly be accounted for by the more advanced students in this department having been replaced by others of less experience. The Manufactured Poplin, designed by Miss Ball, which was exhibited at Vienna in this year, is very effective, and especially deserving of commendation, as is also a Coffee Service by Miss Bessie Birch, of graceful form and harmonious colouring. We trust that in future that the designs for manufacture in the several branches may form a more prominent feature in the Annual Exhibitions, as we feel assured that encouragement would be largely extended in this direction by houses of repute both in this country and in England.

We cannot conclude without bearing testimony to the value we attach to the abilities and zeal of the Head Master, Mr. Lyne, so successfully exercised in the performance of his duties, and whose absence from the adjudication on this occasion in consequence of recent family affliction we sincerely regret. Miss Julyan and the several Art Teachers continue their valuable co-operation.

GEORGE HODSON, Bart.
December 20th, 1873. THOMAS ALFRED JONES, P.R.H.A.

LIST OF AWARDS, 1873.

ROYAL DUBLIN SOCIETY'S PRIZES.

SPECIAL PRIZES FOR TEACHERS.

Sect.	Name.	Prizes.
	Assistant Art Teacher, for a Still Life Group painted:	
	Miss M. A. M'Gee, for a Group in Water Colors, . .	*1st Silver Medal, recommended.*
	Mr. E. A. Byrne, for an Interior of a Class-room in the School of Art, ...	*Special Certificate, recommended.*

CLASS I.—*The figure Drawn, Painted and Modelled, and Anatomy.*

1. Study of full length Figure from the Antique:
   Miss Ismena Benson—(Milo Venus), ... *2nd Silver Medal.*

2. Head painted from the Life:
   Miss Lambert—Female Head in Oil, ... *1st Bronze Medal.*

Sect.	Name.	Prizes.
3.	**Best Drawing from the Antique:**	
	Miss Maria D. Webb—Head of Mercury,	*Special Certificate.*
	Miss Harriet Thornhill—Julian de Medici,	*Special Certificate.*
	Miss Anna Parnell—Monochrome of Clytie,	*Honorable Mention.*
4.	**Best Model from Life or Antique:**	
	Mr. Edward Gibson—Statuette, Falling Gladiator,	*1st Silver Medal.*
	Mr. Robert Catterson Smith—Statuette, Athlete with Struggle,	*2nd Silver do.*
	Miss Kate O'Brien—Low Relief of Milo Venus,	*Special Certificate.*
	Mr. E. Bestick—Head of Milo Venus,	*Special Certificate.*
5.	**Anatomical Study:**	
	Miss Clara Barnes—Two Views of Skull, in Water Colors,	*2nd Silver Medal.*
	Miss M. A. Bredin—Skeleton, in Water Colors,	*Certificate.*
6.	**Outline Figure from the Flat:**	
	Miss L. M. M. O'Cleary—Farnese Hercules,	*1st Bronze Medal.*
	Mr. J. H. Pentland—Farnese Hercules,	*Certificate.*

CLASS II.—*Architecture and Mechanical Drawing.*

1.	*Geometry:*	
	Miss Isabella Backnell,	*2nd Bronze Medal.*
2.	*Perspective:*	
	Miss Florence Walker,	*2nd Bronze Medal.*
	Miss Mary Montgomery,	*Certificate.*
3.	*Projection:*	
	Mr. J. H. Tighe,	*2nd Bronze Medal.*
	Mr. G. Carolin,	*Certificate.*

CLASS III.—*Still Life Groups.*

1.	Still Life—Groups in Oil or Water Color; entire Section commended:	
	Miss Annie Lee—Group in Water Colors,	*1st Silver Medal.*
	Miss Lizzie Langan—Group in Oil Colors,	*2nd Silver Medal.*
	Miss Harriet Thornhill—Group in Oil Colors,	*Certificate.*
	Miss Eleanor Kerr—Group in Water Colors,	*Certificate.*
2.	*Groups shaded in Chalk:*	
	Miss Mary Oliver,	*1st Bronze Medal.*
	Miss A. Ffolliott,	*2nd Bronze Medal.*
	Miss M. Manning,	*Certificate.*

CLASS IV.

1.	Landscapes from Nature:	
	Miss I. Maffett—Water Color Sketches, Isle of Wight,	*Special Certificate.*
	Miss O. E. Poole—Oil Color Study in Rathfarnham Park,	*1st Silver Medal.*
	Mr. G. B. Le Fanu—Various Sketches from Nature,	*Special Certificate.*
2.	*Flowers or Foliage painted from Nature:*	
	Miss M. Martin—Ivy Branch,	*2nd Silver Medal.*
	Miss Eliza Robie—Bignonia,	*Certificate.*
	Miss M. G. M'Sorley—Pelargonium,	*Honorable Mention.*
	Miss M. Lee—Cylamen,	*Honorable Mention.*

Sect.	Name.	Prizes.
3.	*Flowers or Foliage in Outline from Nature:*	
	Miss A. Kellett—Lupin and Grasses, &c., ...	*1st Bronze Medal.*
	Miss M. M'Sorley—Ivy, Daffodils, Rhododendron, &c., .	*Certificate.*
4.	*Flowers or Foliage painted from the Flat:*	
	Miss M. Manning—Wall-flower and Primula, . .	*1st Bronze Medal.*
	Miss H. Hanlon—Pelargoniums, ...	*Certificate.*
5.	*Prize withheld.*	
	Mr. J. Kavanagh, recommended for Sketches of Animals (Special), ...	*1st Bronze Medal.*

CLASS V.—*Ornament; Drawn and Shaded.*

Sect.	Name.	Prizes.
1.	*Ornament from the Flat in Outline:*	
	Miss M. M'Donnell—Tarsia, ...	*2nd Bronze Medal.*
	Miss S. Mullin—Tarsia, ...	*Certificate.*
2.	*Ornament shaded from the Flat:*	
	Miss M. Cochrane—A Roman Pilaster, . . .	*1st Bronze Medal.*
	Miss Jeanie Walker—Frieze from a Church by Saniovino,	*Certificate.*
3.	*Ornament from the Round in Outline:*	
	Prize withheld.	
4.	*Ornament shaded from the Round:*	
	Miss F. L. Jordan—Cast of Apples in Chalk, . .	*1st Bronze Medal.*
	Miss M. Martin—Cast of Plums in Chalk, . . .	*Certificate.*

CLASS VI.—*Designs for Manufactures.*

Sect.	Name.	Prizes.
1.	*Textile Fabrics.*	
A.	*Design for Lace:*	
	Miss F. L. Jordan—English Honiton, ...	*1st Bronze Medal.*
	Miss E. Irwin—Brussels Point, ...	*Special Certificate.*
	Miss M. Irwin—Brussels Point, ...	*Honorable Mention.*
B.	*Design for figured Damask:*	
	S. P. Ball, ...	*1st Bronze Medal.*
C.	*Design for Table Damask:*	
	Miss L. M. M. O'Cleary, ...	*2nd Bronze Medal.*
	Miss F. Montgomery, ...	*Certificate.*
D.	*Design for a Carpet:*	
	Miss S. P. Ball—Brussels, with a Border, . . .	*1st Bronze Medal.*
	Miss M. A. M'Gee—Axminster, ...	*Certificate.*
	Miss M. Manning—Brussels, ...	*Honorable Mention.*
E.	*Design for Muslin Curtains:*	
	Miss S. P. Ball, ...	*Certificate.*

Surface Decoration.

Sect.	Name.	Prizes.
A.	*Design for Wall Decoration:*	
	Miss J. Walker—From Marsh Mallow, . . .	*1st Bronze Medal.*
	Mr. J. Kavanagh—Arabian, in Black and Gold, .	*Certificate.*

Sect.	Name.	Prizes.
B.	*Design for Floor Cloth:*	
	Prize withheld.	
C.	*Design for a Chimney Breast:*	
	Mr. J. T. Miles—In the Renaissance Manner, . .	1st *Bronze Medal.*
D.	*Design for a Vase:*	
	No competition.	
E.	*Design for a Coffee Service:*	
	Miss B. Birch—From Coffee Plant and Berry, . .	1st *Bronze Medal.*

Special Prizes recommended.

Mr. J. T. Boyle—*Design for Spandril, modelled in Clay, Renaissance,*	*Special Certificate.*
Miss C. Mitchinson—*Design for Muslin Dress, Mouse-tail Moss,*	1st *Silver Medal.*
Miss I. Bergin—*Design for Muslin Dress,*	1st *Bronze Medal.*
Miss B. Birch—*For Elementary Design, Forget-Me-Not and Marsh Mallow,*	*Honorable Mention.*

The following Students were successful at the Examination in Artistic Anatomy, held on the 30th June, 1878, by Alexander M'Alister, M.D., Honorary Professor of Artistic Anatomy:—

Miss M. D. Webb, ...	1st *Silver Medal.*
Miss O. E. Poole, ...	2nd *Silver Medal.*

EXAMINATION of PUPILS of DRAWING CLASSES of External Schools in Dublin, May 27th, 1878.

Small Bronze Medals.

L. M. Sands.
L. R. Samuels.
H. Hutton.
M. Elliott.

Certificates.

E. Quarry.
A. Hand.
J. Cutchell.
E. Cowen.
F. S. Marmion.
M. Mooney.
L. O'Connor.
A. Trubshaw.

Second Grade Prizes.

List of Students who have been successful.

Name.	Nature of Examination. Free-hand.	Geometry.	Perspective.	Model.	Prize Selected.	Full Certificate.
Cox, John, . . .	P	E	–	–	Burchet's perspective.	
Evans, Andalusia, .	P	–	–	E	Instruments.	
Fitzgerald, Bolton, .	E	–	–	–	Crayons.	
Hull, Joseph A. . .	P	–	–	E	Colours.	
Kavenagh, Joseph, .	E	–	–	P	Instruments.	
Montgomery, Mary, .	P	P	E	–	Instruments.	
Moran, M. T. H. .	–	P	E	–	Crayons, . .	Certificate.
O'Brien, R. D. . .	–	E	P	E	Wornam's ornament, and Lindley Botany.	Certificate.
Parks, W. Theodore, .	E	–	–	P	Instruments.	
Warren, Mary H. G. .	–	–	–	E	Crayons, . .	Certificate.
White, Frances J. .	E	–	–	P	Instruments.	
Yates, George, . .	–	P	E	–	Instruments, . .	Certificate.
Boucher, James W. .	–	–	–	P	—	Certificate.
Doherty, Thomas, .	–	–	P	–	—	Certificate.
Elliott, Zoe, . .	–	P	P	–	—	Certificate.
Symes, Penella K. .	–	P	P	–	—	Certificate.
Allen, Charles J. .	–	–	–	P		
Allen, Henry, . .	P	–	–	–		
Barnes, Clara, . .	–	P	–	–		
Beale, Thomas, . .	P	–	–	–		
Birch, Bessie, . .	–	–	P	–		
Bradley, Dora, . .	–	–	–	P		
Bradley, Hugh, . .	P	–	–	–		
Browne, Alexander, .	–	P	P	P		
Calcutt, Charles, .	P	–	–	–		
Christian, Albert, .	P	–	–	–		
Coffey, George, . .	–	–	–	P		
Crofton, D. A. . .	P	–	–	–		
Cruise, F. S. . .	P	–	–	–		
Day, B. E. . . .	P	–	–	–		
Douglass, Fredk. A. .	P	P	–	P		
Downes, Alexander H.	P	–	–	–		
Dunne, L. M. A. .	P	–	–	–		
Ellis, John, . . .	P	–	–	–		

P signifies Passed, and entitles the Student to a Certificate Card. E signifies Excellent, and entitles the Student to a Prize.

List of Students who have been successful—*continued.*

Name.		Nature of Examination. Free-hand.	Geometry.	Perspective.	Model.	Prize Selected.	Full Certificate.
Ffolliott, Agnes L.	F.	–	–	–	P		
Ffolliott, M. Y. .	F.	P	–	–	–		
Hanlon, H. J. .	F.	P	–	–	P		
Johnston, Annie, .	F.	–	–	–	P		
Jones, B. P. .	F.	–	P	–	–		
Jones, J. G. .	F.	P	–	–	P		
Kavanagh, Patrick,	.	–	–	–	P		
Keenan, James, .	.	P	–	–	P		
Kernaghan, William,	.	P	–	–	–		
Kirkwood, John J.	.	–	–	–	P		
Lees, M. E. .	F.	P	–	..	P		
Le Fanu, G. B. .	.	–	–	P	–		
Long, William, .	.	P	–	P	P		
M'Donnell, A. .	.	P	–	–	–		
Mackenzie, William H.		–	–	–	P		
Maguire, Amelia,	F.	–	–	P	–		
Manning, Mary R.	F.	–	–	–	P		
Martin, Anna, .	F.	–	P	P	–		
Millard, B. . .	.	–	–	P	–		
Montgomery, Louisa,	F.	–	–	P	–		
Mullin, Sarah, .	.	P	–	–	–		
Mullins, Thomas P.	.	–	–	P	–		
Nangle, Nannie F.	F.	–	P	–	P		
O'Brien, Peter P.	.	P	–	–	–		
O'Callaghan, Thadd. M.		P	P	–	–		
O'Cleary, L. M. M.	.	–	–	–	P		
Palmer, Annie, .	F.	–	–	–	P		
Redmond, H. M. J.	F.	P	–	–	–		
Shaw, George, .	.	P	–	–	–		
Spearing, Eva, .	F.	P	–	–	–		
Spong, William G.	.	P	–	–	–		
Troy, Patrick, .	.	–	P	–	–		
Walker, Mary L. C.	.	P	–	–	–		
White, Arthur T.	.	P	–	–	–		
Williams, L. G. .	.	P	–	–	–		
Worthington, E. .	F.	P	–	–	–		

P signifies Passed, and entitles the Student to a Certificate Card. E signifies Excellent, and entitles the Student to a Prize.

W. F. Steele, M.D., *Registrar.*

G. W. Maunsell, Esq., D.L., Vice-President, then moved a vote of thanks to the judges who had adjudicated the Society's Prizes just distributed. Their duties were sometimes considered perfunctory, but they were in reality most important, and in this instance they had performed them, he might say, to their entire satisfaction. He could not conclude without adverting to the meeting of that night five years ago—the first occasion upon which His Excellency and the Countess Spencer, he believed, made their first public appearance in Ireland. Every one who was present on that night would well remember the kindly phrase in which His Excellency addressed the Students of these Schools when pointing out to them the careers that might be open to them. It had been their lot to find him since in every department of this great Society—in their Agricultural Halls and in their Summer Shows—wherever the wants of the Society had called for him they had found him a kind, an anxious, and an earnest President and Patron. They parted with him as those who had come year by year to value him more highly, and to value the Countess Spencer more highly. In laying down the insignia of his high office he could do so with the feeling that he had not left one enemy behind him in Ireland.

Sir George Hodson, Bart., briefly acknowledged the resolution on behalf of the judges, and proposed the sincere thanks of the Society to His Excellency for coming amongst them that evening—an honour enhanced on this occasion by the presence of the Countess Spencer.

His Excellency the Lord Lieutenant said—Ladies and gentlemen, I rise with no ordinary feelings of embarrassment to address this large and distinguished assembly to-night. I feel that the occupations of the last few weeks have taken up so much of my time that I have not been able, as I should like, to have thought over any topic that might be of interest or useful to the Students to whom I have given prizes with such pleasure to-night, or to the audience I see before me. But I must congratulate the Dublin Society, as I did on the first occasion that I addressed its members, on the work which they do in the furtherance of art in this country. The work which the Society takes in hand is very wide and various, but I am sure it does no more useful work than that of managing Schools of Art in this country. It is a country where art is much appreciated, and where the quick genius of its people readily take to art, and therefore I believe art has no better field than the field of Ireland. We have heard to-night of the success which has attended the School of Art of the Dublin Society; not only are the reports of the eminent men who have acted as judges eminently satisfactory as to the works of all the pupils who came before them, but—and this is what I think we ought to congratulate the Society chiefly upon—we find that the pupils from this School have been highly successful in international competitions, and have carried off more than any other School in the United Kingdom. This is a thing which I think I may well congratulate this Society warmly upon, and especially those under whose able teaching this success has been attained. When I return shortly to my own native county I shall be able to congratulate them, and give them great encouragement by the fact that from a village near to me comes Mr. Lyne, who has been so ably the teacher of this School. I observe that the teaching in this School is very varied; it teaches not only high art in landscape painting and in drawing of living models, but it teaches also modelling and statuary, as well as designs for manufactures of different kinds. This I think is very important, for we all know how difficult it is in education to discover the turn of mind of each pupil. Many a person would have risen to some eminence if his teacher had been

able to discover the particular bent of his intellect and genius. It is one of the difficulties in all education—to develop the character of each of those who come for instruction. This is particularly the case in art, and I consider the variety of subjects which this School and this Society teach tends greatly to develop the genius and intellect of its pupils. If we look to high art in the ancient days, we see a very great difference to what is seen now. In olden days we saw one great master, with a school of artists following his particular style of treatment. We find also particular subjects dwelt upon. In the 15th century we find all the great works of art treating religious subjects. Now we see a great difference. I do not know whether it is that we decorate and do honour to our churches in other ways than in painting, or whether the artists of the present day are somewhat timid in trying to follow the footsteps of the great men who painted in former days, but we see on the walls of our picture galleries every kind and description of art; we find the independence and originality of English and Irish thought breaking out in every direction, and if we lose somewhat of symmetry from want of a particular school, we gain much in the originality and thought which are thrown into the pictures of our artists. This is especially shown in the works of the very great man who departed this life during the past year. I allude to Landseer. In former days we had Honderkoter, Wolvermans, and Snyders delineating with great force, and grace, and vigour animal life; but where can you find the wit, or humour, or touching feeling which we discover in the pictures of Landseer? Now this School does much towards educating and bringing up pupils to the very highest style of art. I was very much gratified to hear from one of the speakers to-night a name well-known in Dublin—the name of a distinguished artist here, whose son is now already commencing his career as a sculptor in the studio of one of the most successful sculptors in this country, Mr. Foley, who is such an honour to this country of Ireland. I sincerely trust that he will follow in the steps of that distinguished artist, and bring not only honour to his own name and that of his father (Mr. C. Smith), but honour to this Society, whose pupil he has been. And now I may allude to a topic which has been referred to by more than one of the speakers who have preceded me. On former occasions I have spoken strongly in favour of having a Central Museum of Ornamental Art in Dublin, and I must freely confess to you that I feel rather mortified and disappointed that on this, which is, perhaps—and I may say not perhaps, but certainly the last occasion on which I shall appear before you as the humble representative of the Queen—I feel rather mortified and disappointed that I have not been able to further an object which I have always felt is of great importance to the furtherance of art in this country. Last year I referred to this matter, but then there was a considerable difficulty in bringing on the subject, because the House of Commons had shown itself more than ordinarily jealous of the expenditure on the Civil Service, and while a committee was sitting upon that we did not think it was a very opportune moment to press for a grant for the purpose of a School of Ornamental Art in Dublin. There are other difficulties in the way arising from the great number of societies which have museums in Dublin, but I had always felt sanguine that with a fair field we should be able to obtain for you the advantage to which I have referred—a central ornamental Art School in Dublin. I, therefore, much regret that neither the Marquis of Hartington—who was equally anxious on the subject—nor I have succeeded in our object. I sincerely trust that our successors may be more fortunate. I wish them every success in this object, and I shall never be jealous of their

better fortune if they are able to establish in Dublin such a museum, which I think of the greatest importance to all lovers of Art in this country, and to all the students of Art within the land. Before resuming my seat I cannot help touching upon another topic which has been uppermost in my mind as I have been sitting here to-night. First of all let me thank my friend who has spoken in so very kind and flattering a manner of Lady Spencer and myself. I assure you that as the days of our stay in Ireland are drawing to a close we experience very painful feelings. There are, of course, many attractions for us at home, where important duties have been rather neglected since we have been here; but we feel deeply to have to leave so many kind friends in Ireland, and so many duties and occupations which have interested us for the last few years, and which have been of greater interest because we believe many of them to have been of great importance to the people of Ireland. I will not dwell on this subject now—this is not the place nor the opportunity for me to give an account of my stewardship—but I will thank this large and distinguished audience, and through this audience the people of Ireland, for the extreme cordiality and kindness with which upon all occasions, in every part of the country, and among every class, they have treated Lady Spencer and myself since our sojourn amongst you. I will only in conclusion say what gratification it is to me to attend a meeting of this character—and of the society which has done so much good for Ireland—on the last occasion when I have, as Lord Lieutenant of Ireland, to address an Irish audience. If I say farewell to you, I hope you will allow me to assure you that it is only a farewell in person, for my thoughts and feelings will always be with you, and I shall ever devote myself to my utmost endeavour to do what I think is for the welfare and the prosperity of the Irish people.

The proceedings having terminated, their Excellencies and the general company adjourned to the museums, which were thrown open and brilliantly illuminated for the occasion.

EVENING SCIENTIFIC MEETINGS.

MONDAY EVENING, NOV. 17, 1873.

GILBERT SAUNDERS, Esq., in the Chair.

Mr. HOWARD GRUBB, C.E., read a Paper "On Clocks for Equatorial Telescopes," and Exhibited Diagrams in Illustration.

PROFESSOR J. E. REYNOLDS then gave a description of "Ecchovus' Ball-peat Making Machine." Last year Mr. Alexander Macdonnell brought before the notice of the Royal Dublin Society a number of Peat-Preparing Processes; and since then the interest felt in the subject had not diminished. The process Professor Reynolds was about to describe was largely employed in Germany and Sweden, and the produce was used on various State railways. Dr. Reynolds had examined some of the specimens from Germany and Sweden, and found them to be very good chemically. The process, which was very simple, was successful in both countries. The essential parts of the apparatus were sketched on the blackboard, and explained. There was no peculiar mode of cutting the turf in the first instance. The rough but suitable peat is

delivered to a machine consisting of an external casing laid horizontally. with a revolving shaft, furnished with teeth set in screw fashion along it. The peat is gradually reduced to a paste, pushed forward by the action of the screw, and disintegrated. It is then forced through the conical end of the machine, and issues as a soft cylinder. There is a knife at the end of the apparatus which cuts the cylinder from time to time into convenient pieces. These are placed on a lift, and raised to a considerable height. They are delivered on an inclined plane, and rolled down into a machine shaped like a truncated cone, which revolves rapidly, and rolls the cylinders by degrees into a spherical form; after which they fall into little trucks or barrows. The object of the lift is to raise the peat to such a height that the trucks have no difficulty in being shunted along to a drying shed. The peat is delivered in one or other of peculiarly constructed inclined planes in a drying shed. Behind the front stage is another, which is also filled. After an exposure, the length of which is regulated by the state of the atmosphere, the dry balls are allowed to roll off into a store; the others roll down into their places, and thus the balls are shifted with very little manual labour by simple gravitation. The time required for drying by this method is stated to be about one-eighth less than that required in ordinary flat sheds. The specimens on the table are approximately spherical in form, and vary a little in size, averaging about three inches in diameter. The heating power of this peat is very large, being to ordinary coal as 1⅝ to 1; while that of ordinary peat is as 2¼ or 2½ to 1. The ball peat having been very carefully pulped is not so hygroscopic as ordinary peat. The former contains only 15 per cent. of water, instead of from 20 to 25. The relative vacuum occupied by equal weights of Staffordshire coal, ball peat, and ordinary light turf was measured by a new sand method with the following results:—

Coal, ...	= 1·00
Swedish ball peat, ...	= 1·37
Light turf, ...	= 4·12

This was important as regards the question of storage. Each machine yields 1,700 tons of dried and prepared peat per annum in Sweden. It was said that this peat could be produced at about 5*s*. or 6*s*. per ton.

The Chairman said that the important question of the utilization of the bogs had been before the Irish public for many years. He has had practical experience of many experiments, all of which failed. But at that time coal was 12*s*. or 15*s*. per ton in Dublin. Nevertheless, the Mountmellick peat at 3*s*. 3*d*. per ton delivered could not compete with coal at 18*s*. The peat formed a fuzzy, light mass, and went away in the furnaces. Mr. Dargan could not use it for working the steam-boats on the Shannon. The peat made at Derrylea was pressed and partly dried. It could not be sold in Dublin under 15*s*. per ton, and could not compete with coal at 17*s*. 6*d*. per ton. The method which Dr. Reynolds had described presents many advantages. Much time was lost in attempting to dry large masses. It was said at Derrylea that peat would not dry, unless pressed when wet; and it usually contained from 20 to 25 parts of water. Consequently it often burst when thrown into a hot fire, and the red hot fragments were scattered about the room; in fact it could not be used without a fire-screen.

Professor Reynolds observed that there was no such danger with this peat.

Mr. J. Adair thought that peat could not compete with coal; but

that the chief advantages of this peat were its small size, cheapness, and its not being liable to split.

Mr. MANNING remarked on the importance of knowing what was being done elsewhere. One great advantage of this peat seems to be that it does not occupy more than about double the space of the same weight of coal.

Mr. DILLON said that locomotive engines were obliged to be constructed with brick arches to counteract the effects of any sulphureous vapours or gases given off by the fuel. These arches were not only very expensive, but they sometimes fall down and stop the engine on its way. Was peat more or less liable to a similar objection? Would ordinary locomotive fire boxes hold enough peat? How is peat used on Canadian railways?

Rev. Mr. BAGOT asked if there was any difference between Irish and Swedish peat. The great difficulty at Derrylea was the fibrous matter in the peat. An engine driver who tried to use peat with a steam threshing machine, had to give it up in a fortnight, because it was found to destroy the tubes of the engine.

PROFESSOR REYNOLDS said that the ball peat he had examined contained less sulphur than ordinary Coal. A necessarily large amount of gas was produced by the action of the water contained in peat. This was of considerable advantage for many purposes. The same bulk of peat and coal will not give off the same amount of heat; but the space required for ball peat is not so great as for light turf. Peat need not be used in engines. If we could provide peat suitable for ordinary consumption, we might leave the coal for the engines. The Canadian process was different from that which he had described, but he could give no information respecting it. The raw peat used in Sweden is said to be similar to ordinary middle peat, and they work down to the dense lower peat. The fibrous middle peat is found to be reduced to a sufficiently fine state by the described process. In absence of any direct evidence, Dr. Reynolds was inclined to think that the engine tubes were destroyed by the mechanical effect of the flame from the light peat ordinarily used, and not by any chemical agent.

Rev. Mr. BAGOT suggested that there might be some peculiar quality in the bog from which the peat was taken, which caused the mischief.

In reply to a further question, Professor Reynolds said that a patent had been taken out in Germany for the manufacture of ball peat.

Several specimens of Birds of Paradise, and other rare ornithological specimens recently added to the Society's Museum, were placed on the table for exhibition.

MONDAY EVENING, DECEMBER 15, 1873.

HOWARD GRUBB, C.E., in the chair.

JOHN MALLET PURSER, M.B., Univ. Dubl., delivered a discourse "On the Production of Musical Sounds by the Human Voice."

MONDAY EVENING, JANUARY 19, 1874.

ROBERT S. BALL, LL.D., in the chair.

MAJOR COLLINS, R.E., read a Paper, "On the Production of Circular Motion without Dead Points, from Reciprocating Motion.

MAJOR COLLINS also made a communication, "On a Method of Estimating Heavy Weights."

W. F. KIRBY, Assistant Naturalist in the Museum, made a communi-

cation entitled, "Additional Notes on the Species of Silkworms in the Society's collection."

Professor J. E. Reynolds explained the "Laws of the Diffusion of Gases," and illustrated it by means of an instrument consisting of a three-necked vessel, furnished with a glass tube, terminating above in a porous cylinder, over which a bell-glass full of hydrogen was held. Hydrogen diffuses into air about four times faster than air into hydrogen. Such an instrument, with a platinum wire sealed into one end, and a metallic conductor at the other, attached to a bell-ringing apparatus, might be used to detect fire-damp in mines. Its presence would cause contact between the wires, and ring the bell. This is Mr. Ansell's discovery. He first used mercury, but now finds water answer better. Dr. Reynolds prefers acidulated glycerine, saturated with water; but fire-damp when diffusing slowly excites no special motion. This may be remedied by keeping a glass cover perfectly sealed over the apparatus. For the detection of choke-damp this apparatus must be exactly reversed, as it is much heavier than air.

Professor W. F. Barrett said that Ansell's plan could not be practically carried out. When the flame of hydrogen is brought into contact with other gases it is tinged with other colours. The flame of hydrogen is turned to lilac by the presence of only one per cent. of carbonic acid. The tint of the flame would show when danger was present. It would turn to pink in the presence of fire-damp. This was an infallible test, without the inconvenience of Ansted's. When any unglazed substance is held over a blown-out gas jet the gas diffuses so rapidly through, that you can light the gas above, as may be seen by placing two funnels mouth to mouth, with a piece of leather between. Gas consists chiefly of the lighter hydrocarbons. If coal-gas were passed through a tube of papier-mache, surrounded by a cylinder, the illuminating part could be separated, and the heating part withdrawn, and returned to the furnace.

The Chairman said that hydrogen would diffuse itself regardless of pressure on the other side, which was an interesting mechanical paradox.

Monday Evening, February 16, 1874.

Howard Grubb, c.e., in the chair.

Professor Hull, f.r.s., delivered a discourse on "Glaciers, Ancient and Modern," which was copiously illustrated by Photographs, exhibited on the screen by Mr. Porte.

Monday Evening, March 16, 1874.

Professor Hull, f.r.s., in the chair.

Charles R. C. Tichborne, Chemist to the Apothecaries' Hall, Dublin, read a Paper "On the Photographic Action of Fluorescent Substances."

W. R. M'Nab, m.d., Professor of Botany, Royal College of Science, read a communication "On the Distribution of the Sclerenchymæ of Mettenius in Plants."

Monday Evening, April 20, 1874.

Professor J. Emerson Reynolds in the chair.

W. F. Barrett, f.r.s.e., f.c.s., &c., Prof. Physics, Royal College of Science, Ireland, delivered a discourse entitled, a "Fragment of Faraday's Discoveries in Magnetism and Electricity." He gave a brief sketch of Faraday's life, and referred to the dominant idea that animated

his researches, namely, the mutability of energy, the immutability of matter. His discovery of electricity evoked by magnetism, which led to magneto-electricity and its practical applications; next his discovery of the so-called magnetization of light; then the discovery of dia-magnetism, or the influence of magnetism on all substances; and, lastly, his discovery of current electrical induction were described. The discourse, which was copiously illustrated by experiments, terminated in a series of views of Faraday's laboratory, exhibited on the screen by the lime-light.

MONDAY EVENING, MAY 18, 1874.

ALEXANDER MACDONNELL, C.E. read a Paper "On the Use of Peat in Siemen's Regenerative Gas Furnace."

DR. JAMES M. BARRY read a communication, "On the Present Condition of the Suez Canal."

Two specimens of the "Resplendent Trogon" (*Trogon pavoninus*), and a specimen of the gray Apteryx (*Apteryx Owenii*) were exhibited.

DUBLIN: Printed by ALEXANDER THOM, 87 & 88, Abbey-street,
For Her Majesty's Stationery Office.
[96.—500.–4, 75].

INDEX.

ANATOMY, comparative and homological, recent advances in. *See* Macalister, Professor, 35.
Andrews, Mr. William, on the coast fisheries of Ireland, 397.
Andrews, Thomas, M.D., F.R.S., on the liquid and gaseous states of matter, 55.
Angle-measurer and protractor, for facilitating the processes of field sketching and surveying. *See* Collins, Major, 215.
Aniline, a constituent from coal tar, 11.
Anthracene, a colour from coal tar, 11–19.
Alizarine, a colour from coal tar, 19.
Apes, anthropoid. *See* Macalister, Professor, 418.
Amphioxus lanceolatus, description of, 38.
Aurine, a colour from coal tar, 18.
Art, schools of, reports of head master for the year 1871-2, 228, 439.
Arts, Fine, 524.
Art, school of, distribution of prizes to the students of, 159, 227, 435.
Art, works of, report of judges on Christmas, 1870, 167.
—— Christmas, 1870, 232.

Ball, Professor Robert S., on energy, 187.
—— account of experiments upon the mechanical efficiency of different forms of pulley-blocks, 70.
Barry, Dr. James M., on cotton growing in Fiji, 205.
Benzol, a constituent of coal tar, 11.
Blue dyes from coal tar, 17.
Botanic Gardens, donations to, 151, 228, 434, 519.

Calamites. *See* Mr. R. Mac Nab, 473.
—— their relation to equisetum or "horse-tails" of the present day. *See* Mr. R. Mac Nab, 471, 473.
Carbonic acid, signification of, 57.
Carboxytic acid, a colour from coal tar, 18.
Cattle Show, Spring, 1872, 345.
—— " " 1873. 456.
Charlier, Mons., on a new method of horse-shoeing, 52.
Climate of Ireland with reference to the cultivation of flax. *See* Hennessy, Professor, 1.
Coal fields, extension of, in England, under the new formation. *See* Hull, Professor, 141.
—— gas and its flame. *See* Reynolds, Professor, 189.
—— mining, present state of, in Tyrone. *See* Hardman, Edward F., 366.
—— tar, colours from. *See* Draper, Harry N., 7.
Collins, Major W. H., on a new angle-measure and protractor, 215.

Direction of wind and rainfall, results as to mean temperature, 463.
Donations, return of, 142, 217, 427, 519.
Draper, H. N., on colours from coal tar, 7.
Dust, atmospheric. *See* Tichborne, Charles R. C., 22.

Ede's epicycloidal pulley-block, mechanical efficiency of, 74.
Energy. *See* Ball, Professor, 187.
—— distribution of, throughout the Universe, 188.
—— cannot be created, 188.
—— indestructibility of, 189.
Equisetum, structure of, 471.

Fertilizers, artificial, comparative trials of. *See* Tanner, Professor, 387.
Fiji, cotton growing in, with remarks on country and inhabitants of. *See* Barry, Dr. James, 205.

Fisheries, sea coast, of Ireland. *See* Andrews, William, 397.
Flax—rainfall in Ireland, Belgium, and the Baltic provinces of Russia, during the months of the growing of, 6.
—— temperature tables of the months of cultivation of, in Ireland, 3.
—— in the Baltic provinces of Russia, 4.
—— in Belgium and Holland, 4.
—— in Egypt, 5.

Gases, inquiry into the cause of the interrupted spectra of, and also the absorption spectrum of chlorochromic anhydride. *See* Stoney and Reynolds, Messrs., 83.
Glaciers, ancient and modern. *See* Hull, Professor Edward, 505.
Green dyes from coal tar, 17.
Grubb, Howard, on clocks for equatorial telescopes, 474.

Hardman, Mr. Edward F., on the present state of coal mining in Tyrone, 366.
Heat, theory of, also some of its applications to arts and manufacture. *See* Mac Donnell, Alexander, C. E., 494.
Hennessy, Professor H., on the climate of Ireland with reference to cultivation of flax, 1.
Hoffmann's dyes from coal tar, 18.
Homologies of the upper and lower extremities, 43-45.
Horse shoeing, new method of. *See* Charlier, Mons., 53.
Hull, Professor Edward, on the extension of English coal fields under the new formation, 141.
—— on glaciers, ancient and modern, 505.

Intelligence, 159, 227, 438.

Kirby, William F., notes on specimens of saturnidæ, 201.
—— notes on three species of trap-door spider, 67.
—— list of species of sphingidæ, 60.
—— list of species of papilioninæ, or swallow-tailed, 68.

Library, donations to the, 142, 217, 427.
Lighthouses, gas for illuminating. *See* Wigham, Mr., 192.

Loranthus Europeus, successful establishment of, on oak trees in the Botanic Gardens. *See* Moore, David, Ph. D., 383.

Macalister, Alexander, M. D., on recent advances in comparative and homological anatomy, 85.
—— on anthropoid apes, 418.
—— on rudimental and provisional organs, 509.
Macdonnell, Alexander, C. E., on the theory of heat and its application to arts and manufactures, 494.
—— on the use of peat in Siemen's regenerative gas furnace, 503.
Mac Nab, William R., M. D., on distribution of sclerenchyma of Mettenius in plants, 516.
—— on calamites and their relation to equisetums, 471.
Manchester yellow, a colour from coal tar, 19.
Matter, continuity of the liquid and gaseous states of. *See* Andrews, Thomas, M. D., 55.
Magenta, a colour from coal tar, 11.
Mauve, a colour from coal tar, 13.
Mercury, nature and constitution of, with certain ketones. *See* Reynolds, Professor, 76.
Meetings, scientific evening, 181, 352, 457.
Meteorological journals, appendix.
Mineralogical tables arranged for facilitating the examinations of the mineral collection in the Museum. *See* Reynolds, Dr. E., 84.
Morphology of animals, the state of, 37.
Musical sounds produced by the human voice. *See* Purser, Dr., 75.
Moore, David, Ph. D., on the death of a screw pine in the Botanic Gardens, 50.
—— on the successful establishment of Lorenthus Europeus on oak trees in the Botanic Gardens, 383.
Moore and Head's patent hand-hoist, mechanical efficiency of, 75.

Naphthalin, a constituent of coal tar, 11.
Natural History Museum, donations to the, 154, 224, 455, 521.
Nitrobenzol, 12.

Organs, rudimental and provisional. *See* Macalister, Alex., M. D., 509.

Papilioninæ, list of the species of, in the Museum. *See* Kirby, W. F., 63.
Purser, Dr., on the production of musical sounds by the human voice, 483.
Picric acid, a colour from coal tar, 18.
Phenol, a constituent of coal tar, 11.
Pulley-block, three-sheaves, mechanical efficiency of. *See* Ball, Professor, 74.
—— Moore's patent experiments with. *See* Ball, Professor, 75.
—— Weston's differential. *See* Ball, Professor R. S., 74.
—— experiments on mechanical efficiency of different forms of. *See* Ball, Professor, 70.
—— Ede's epicycloidal, experiments with. *See* Ball, Professor, 74.
Pulley, single, moveable. *See* Ball, Professor, 73.

Reynolds, Dr. Emerson J., on the action of sunlight on iodide of silver, 210.
—— on the adulteration and valuation of superphosphates, 359.
—— on coal gas and its flame, 189.
—— mineralogical tables, 84.
—— on mercury, 76.
Rosolic acid, a colour from coal tar, 18.

Saturnidæ or ocellated silkworms, notes on specimens of. *See* Kirby, William F., 201.
Sclerenchyma of Mettenius, distribution of, in plants. *See* Mac Nab, W. R., M. D., 516.
Scientific lectures, titles of, 456.
Siemen's regenerative gas furnace, use of peat in. *See* Macdonnell, Mr. Alexander, 508.
Screw pine, death of, in Botanic Gardens. *See* Moore. Dr. D., 50.
Silver, iodide of, action of sunlight on. *See* Reynolds, Professor J. E., 210.
Single movable pulley block, mechanical efficiency of. *See* Ball, Professor, 73.
Sphingidæ, list of species of, in Museum. *See* Kirby, W. F., 60.
Spiders, trap-door, notes on three species of, in the Museum. *See* Kirby, W. F., 67.
Stoney, George Johnstone, A.M., F.R.S., and Reynolds, J. E., on interrupted spectra of gases, also absorption spectrum of chlorochromic anhydride, 88.
Superphosphates, adulteration and valuation of. *See* Reynolds, Dr. E. J., 359.

Tanner, Professor, on artificial fertilizers, 387.
Telescopes, equatorial clocks for. *See* Grubb, Howard, C. E., 474.
Tichborne, Charles R. C., on atmospheric dust, 22.
Toluol, a colour from coal tar, 11.

Weston's differential pulley-block, mechanical efficiency of, 74.
Wigham, Mr. J., on gas for illuminating lighthouses, 192.

END OF VOL. VI.

APPENDIX.

METEOROLOGICAL JOURNAL,

KEPT AT

The Royal Dublin Society's Botanic Garden, Glasnevin,

[HEIGHT ABOVE LEVEL OF SEA, 65 FEET,]

FROM

1st JANUARY, 1874, to 31st JULY, 1874.

JANUARY, 1874.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Thursday, . . .	29·960	44	29·987	46	38	37	40	42	47	45	S. W.	0	. .	Breezy, cloudy, changeable.
2 Friday, ...	29·628	42	29·660	43	46	44	40	42	44	42	S. W.	1	·340	Breezy, occasional showers.
3 Saturday, . . .	29·312	36	29·360	38	34	33	37	40	39	38	N. W.	1	·510	Breezy, heavy rain, snow showers.
4 Sunday, . . .	29·526	35	29·579	35	32	30	35	36	36	34	N. W.	1	. .	Breezy, cloudy, snow showers.
5 Monday, . . .	29·888	36	29·942	38	30	28	34	37	39	37	N. W.	3	. .	Breezy, cold, bright sun.
6 Tuesday, . . .	30·186	43	30·168	44	34	32	36	35	45	43	S. W.	0	. .	Breezy, cloudy, changeable.
7 Wednesday, . .	29·800	46	29·820	47	39	37	38	39	47	46	S. E.	0	. .	Do.
8 Thursday, . . .	29·436	47	29·457	49	44	42	39	41	50	48	S. W.	0	·020	Cloudy, light showers.
9 Friday, ...	29·664	38	29·707	43	36	34	39	41	46	48	S. W.	2	. .	Fine, breezy, bright sun.
10 Saturday, . . .	30·010	38	30·052	41	31	29	37	40	43	41	N. W.	2	. .	Do.
11 Sunday, . . .	29·900	42	29·932	44	29	27	37	38	45	43	S. W.	0	. .	Breezy, cloudy, changeable.
12 Monday, . . .	29·848	43	29·880	44	40	38	39	41	46	44	S. W.	3	·060	Breezy, showery, bright sun.
13 Tuesday, . . .	29·930	44	29·957	46	38	31	38	39	46	45	S. W.	2	. .	Breezy, cloudy, occasional sun.
14 Wednesday, . .	29·828	46	29·848	48	42	40	40	41	49	48	S. W.	0	·000	Breezy, cloudy, light showers.
15 Thursday, . . .	29·580	50	29·589	52	44	42	42	43	52	50	S. W.	2	. .	Breezy, cloudy, occasional sun.
16 Friday, ...	29·224	38	29·267	39	36	35	39	42	39	38	N. W.	0	·660	Cloudy, heavy rain, changeable.
17 Saturday, . . .	29·540	36	29·588	38	31	29	36	39	39	37	S. W.	3	. .	Breezy, cold, bright sun.
18 Sunday, . . .	29·250	53	29·255	54	32	30	40	41	54	52	S. W.	2	·090	Strong breeze, showery, occasional sun.
19 Monday, . . .	29·524	43	29·556	45	41	39	39	41	47	45	S. W.	1	. .	Breezy, cloudy, changeable.
20 Tuesday, . . .	29·200	48	29·215	49	41	39	41	42	50	48	S. W.	1	·200	Stormy, showery, occasional sun.
21 Wednesday, . .	30·000	45	30·024	47	40	38	40	41	49	47	S. W.	3	. .	Fine, breezy, bright sun.
22 Thursday, . . .	30·240	47	30·259	51	37	36	41	42	53	49	S. W.	3	. .	Do.
23 Friday, ...	30·050	49	30·064	50	41	39	42	43	50	49	S. W.	0	. .	Breezy, cloudy, changeable.
24 Saturday, . . .	30·238	41	30·275	42	38	37	40	42	44	42	S. W.	3	·090	Breezy, showery, bright sun.
25 Sunday, . . .	30·400	43	30·432	44	36	35	38	40	45	43	S. W.	3	. .	Breezy, cloudy occasional sun.
26 Monday, . . .	30·332	49	30·340	50	43	41	40	42	50	49	S. W.	0	. .	Breezy, cloudy, changeable.
27 Tuesday, . . .	30·512	49	30·525	50	46	44	43	43	51	50	N. W.	0	·030	Breezy, cloudy, light showers.
28 Wednesday, . .	30·530	45	30·554	45	44	42	42	43	46	45	S. W.	0	. .	Breezy, cloudy, changeable.
29 Thursday, . .	30·288	44	30·314	46	40	39	41	43	47	46	S. W.	3	. .	Fine, breezy, light sun.
30 Friday, . . .	30·480	43	30·512	45	38	37	41	43	47	45	N. W.	3	. .	Do.
31 Saturday, . . .	30·506	43	30·537	44	39	37	40	42	45	44	N. W.	0	. .	Breezy, cloudy, changeable.
												42	2·006	inches.

FEBRUARY, 1874.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Sunday, . . .	30·440	42	30·472	42	40	38	40	42	43	41	S. W.	0	·000	Cloudy, mild, changeable.
2 Monday, . .	30·288	48	30·302	49	42	40	41	43	50	47	S. W.	1	·000	Cloudy, mild, occasional sun.
3 Tuesday, . .	30·380	43	30·410	49	34	33	41	43	51	48	S. E.	2	·000	Do.
4 Wednesday, .	30·462	35	30·515	40	31	30	39	42	41	40	N. E.	0	·000	Cloudy, foggy, changeable.
5 Thursday, . .	30·414	32	30·474	37	27	26	37	39	39	32	S. E.	1	·000	Foggy, occasional sun, sharp frost.
6 Friday, . . .	30·330	31	30·395	37	24	22	35	37	39	32	N. W.	1	·000	Do.
7 Saturday, . .	30·250	42	30·282	45	31	29	36	37	46	45	S. W.	0	·010	Cloudy, light showers, changeable.
8 Sunday, . .	30·180	42	30·212	42	41	40	38	39	42	40	S. E.	1	·050	Breezy, showery, occasional sun.
9 Monday, . .	30·250	35	30·305	39	29	27	37	38	41	38	S. E.	0	·000	Cloudy, cold, changeable.
10 Tuesday, . .	30·276	38	30·318	39	35	33	35	38	40	39	S. E.	0	·000	Breezy, cloudy, cold, changeable.
11 Wednesday, .	30·020	36	30·068	37	34	32	34	36	38	37	S. E.	0	·000	Do.
12 Thursday, . .	29·850	37	29·898	38	35	34	34	36	39	38	S. E.	0	·180	Cloudy, showery, changeable.
13 Friday, . . .	29·572	50	29·582	54	36	34	38	39	55	52	S. E.	1	·110	Breezy, showery, occasional sun.
14 Saturday, . .	29·288	50	29·298	53	45	43	40	41	54	51	S. W.	2	·040	Do.
15 Sunday, . . .	29·098	45	29·124	47	41	40	40	41	48	46	S. W.	1	·260	Cloudy, showery, occasional sun.
16 Monday, . .	29·468	44	29·496	46	35	33	39	41	46	45	S. W.	3	·100	Breezy, showery, bright sun.
17 Tuesday, . .	29·250	42	30·253	43	38	36	38	41	44	42	S. W.	2	·040	Do.
18 Wednesday, .	29·650	42	29·082	43	32	31	37	39	44	42	S. W.	3	·000	Fine, breezy, bright sun.
19 Thursday, . .	30·020	44	30·046	47	32	30	37	39	48	46	S. W.	4	·000	Do.
20 Friday, . . .	30·000	46	30·019	49	36	34	38	39	50	48	S. E.	0	·030	Cloudy, mild, light showers.
21 Saturday, . .	29·780	50	29·789	50	47	45	40	41	50	49	S. W.	1	·020	Do.
22 Sunday, . . .	29·790	44	29·817	46	34	33	40	42	47	46	N. W.	3	·090	Breezy, showery, occasional sun.
23 Monday, . .	29·800	43	29·832	47	31	30	38	40	48	47	S. E.	0	·000	Cloudy, mild, changeable.
24 Tuesday, . .	29·846	49	29·860	50	42	40	40	42	51	49	S. E.	2	·000	Cloudy, mild, occasional sun.
25 Wednesday, .	29·276	46	29·297	46	42	40	40	42	47	45	S. W.	0	·020	Breezy, light showers.
26 Thursday, . .	28·700	50	28·711	52	48	41	42	43	53	49	S. W.	3	1·280	Stormy, heavy rain, light sun.
27 Friday, . . .	28·908	45	28·936	47	41	39	40	42	47	46	S. W.	2	·060	Breezy, light showers, occasional sun.
28 Saturday, . .	29·746	46	29·766	48	35	34	40	41	50	47	S. W.	2	·000	Breezy, cloudy, occasional sun.
												35	2·240	Inches.

MARCH, 1874.

DATE. Day, At 12 o'Clock, P.M.	BAROMETER. Observed Height.	Therm.	Corrected for Temperature only.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	10 in.	Dry.	Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
		°		°	°	°	°	°	°	°				
1 Sunday, . . .	29·622	46	29·642	47	41	40	40	41	48	47	S. E.	1	·030	Cloudy, light showers, occasional sun.
2 Monday, . . .	30·292	45	30·318	46	37	36	40	41	47	46	S. E.	0	·000	Cloudy, calm, changeable.
3 Tuesday, . . .	31·400	50	30·408	52	44	42	41	43	53	51	S. E.	0	·000	Do.
4 Wednesday, .	30·440	49	30·454	53	40	38	43	44	55	52	S. W.	4	·000	Fine, mild, bright sun.
5 Thursday, . .	30·440	51	30.448	52	46	45	43	45	53	50	S. W.	3	·000	Breezy, cloudy, occasional sun.
6 Friday, . . .	30·744	49	30·757	49	43	41	44	45	50	48	S. E	4	·000	Do.
7 Saturday, . .	30·520	47	30·538	51	31	30	41	44	52	49	S. W.	5	·000	Fine bright sun, light frost.
8 Sunday, . . .	29·940	48	29·954	50	33	31	40	42	51	48	S. W.	3	·000	Breezy, cloudy, occasional sun
9 Monday, . . .	29·650	39	29·693	42	29	28	38	41	43	40	N. W.	2	·090	Breezy, cloudy, snow showers, occasional [sun.
10 Tuesday, . . .	29·840	34	29·894	36	25	23	34	37	37	32	N. W.	2	·000	Breezy, occasional sun, sharp frost.
11 Wednesday, . .	30·144	35	30·197	38	24	22	34	37	39	34	N. W.	4	·000	Do.
12 Thursday, . .	30·196	43	30·208	46	31	29	35	37	47	45	S. W.	2	·030	Breezy, light showers, occasional sun.
13 Friday, . . .	30·396	45	30·422	46	37	35	38	39	47	45	N. W.	1	·000	Breezy, cloudy, occasional sun.
14 Saturday, . . .	30·428	48	30·442	49	40	38	39	40	50	47	S. W.	1	·000	Do.
15 Sunday, . . .	30·300	50	30·308	52	45	43	41	42	52	49	S. W.	0	·000	Breezy, cloudy, changeable.
16 Monday, . . .	30·132	50	30·140	51	45	43	42	43	51	48	S. W.	0	·000	Do.
17 Tuesday, . . .	30·044	54	30·044	55	49	47	45	45	55	51	S. W.	0	·000	Do.
18 Wednesday, .	30·050	51	30·058	51	44	42	44	46	52	49	N. W.	4	·030	Breezy, bright sun, light showers.
19 Thursday, . .	29·800	50	29·808	51	35	34	43	44	53	51	S. W.	0	·100	Breezy, heavy showers.
20 Friday, . . .	30·078	50	30·086	52	39	38	42	44	53	50	S. W.	4	·000	Fine, breezy, occasional sun.
21 Saturday, . .	29·850	52	29·854	53	45	43	43	44	54	52	S. W.	0	·000	Breezy, cloudy, changeable.
22 Sunday, . . .	29·996	57	29·988	59	46	44	46	46	59	57	S. W.	2	·050	Breezy, light showers, occasional sun.
23 Monday, . . .	30·188	58	30·174	59	45	43	46	47	62	58	S. W.	5	·000	Fine, breezy, light sunshine.
24 Tuesday, . .	30·338	54	30·336	56	46	44	47	48	57	54	S. E.	5	·000	Do.
25 Wednesday, .	30·346	53	30·349	53	43	41	46	48	54	52	S. E.	5	·000	Do.
26 Thursday, . .	30·148	58	30·157	54	42	40	46	48	55	50	S. E.	5	·000	Do.
27 Friday, . . .	29·664	51	29·673	51	48	46	45	46	51	49	S. E.	0	·000	Breezy, cloudy, changeable.
28 Saturday, . .	29·720	49	29·734	50	38	37	45	44	50	48	S. W.	1	·020	Stormy, light showers, occasional sun.
29 Sunday, . . .	29·540	56	29·532	57	46	44	46	47	59	56	S. W.	1	·370	Breezy, wet, occasional sun.
30 Monday, . . .	29·796	48	29·810	50	40	38	44	46	52	51	S. W.	3	·130	Breezy, cloudy, occasional sun.
31 Tuesday, . .	29·654	49	29·685	49·5	45·2	43	45	46	50	44·1	S. W.	8	·100	Do.
												75	·950	inches

APRIL, 1874.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	BAROMETER. Therm.	BAROMETER. Corrected for Temperature only.	THERMOMETER. Max.	THERMOMETER. Min.	THERMOMETER. On Grass.	THERMOMETER. In Earth. 5 in.	THERMOMETER. In Earth. 10 in	THERMOMETER. Dry.	THERMOMETER. Wet.	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
1 Wednesday, .	29·950	55·0°	29·966	53·9°	39·0°	38°	42°	44°	52·5°	46·2°	S. W.	7	·090	Breezy, cloudy, occasional sun.
2 Thursday, . .	29·050	56·4	29·061	53·0	46	44	43	45	55·4	53·0	S. W.	5	·040	Do.
3 Friday, . . .	29·156	51·0	29·183	48·1	38·9	37	42	44	49·3	42·2	S. W.	4	·280	Do.
4 Saturday, . .	29·152	52·0	29·174	58	34 9	33	41	43	51·2	44·2	S. W.	8	·000	Fine, breezy, bright sun.
5 Sunday, . . .	29·402	54·9	29·419	57·3	37·0	35	42·0	44·0	52·9	45·6	S. W.	8	·000	Do.
6 Monday, . .	29·852	52·0	29·873	57·0	35·3	33	41·0	43·0	51·2	47·3	S. W.	7	·050	Breezy, showery, bright sun.
7 Tuesday, . .	29·757	50·1	29·783	57·2	34·2	32	42·0	44·0	49·1	45·5	S. E.	0	·000	Breezy, cloudy, changeable.
8 Wednesday, .	29·801	55·0	29·817	52·0	36·0	34	42·0	44 0	54·0	47·1	S. W	8	·100	Breezy, showery, bright sun.
9 Thursday, . .	29·428	59·2	29·433	57·0	43·0	41	44·0	45·8	59·0	51·0	S. W	9	·170	Do.
10 Friday, . . .	29·356	54·1	29·373	51·0	36·0	34	43·8	45·6	53·7	46·5	S. W.	10	·050	Do.
11 Saturday, . .	29·252	47·0	29·290	45·0	32·0	31	41·6	43·8	45·2	43·1	S. E.	7	·040	Breezy, hail showers, occasional sun.
12 Sunday, . . .	29·700	55·2	29·715	51·0	32·4	31·0	42·8	44 6	53·0	45 1	N. E.	10	·020	Hail showers, bright sun.
13 Monday, . . .	28·903	46·6	29·042	45·6	41·0	39·0	42·2	44 0	45·1	44·3	S. E.	0	·170	Cloudy, wet, changeable.
14 Tuesday, . .	30·057	54·1	30·072	51·5	40·5	38·2	43·6	44·8	53·1	42·2	S. E.	7	·140	Breezy, showery, occasional sun.
15 Wednesday, .	30·155	57·4	30·163	55·2	35·9	33·2	44·8	45·8	55·4	55 8	S. W.	8	·000	Breezy, cloudy, occasional sun.
16 Thursday, .	30·052	55·1	30·066	52·0	40·1	38 4	45·4	47·1	53·2	53·2	S. W.	8	·020	Breezy, light showers, occasional sun.
17 Friday, . . .	30·054	50·0	30·076	48·0	43·0	41·1	44·8	46·4	48·1	48·1	S. W.	6	·000	Breezy, cloudy, occasional sun.
18 Saturday, . .	30·048	59·0	30·051	56·0	48 4	46 2	47·4	48·1	57·0	57·0	S. W.	3	·130	Breezy, showery, occasional sun.
19 Sunday, . . .	30·108	65·1	30·095	61·0	50·4	48 2	49·5	50·7	65·8	64·5	S. W.	11	000	Fine, mild, bright sun.
20 Monday, . .	30·032	64·6	30·019	61·9	50·1	48·0	50 6	51·4	64·9	64·6	S. W.	10	·000	Fine, breezy, bright sun.
21 Tuesday, . .	29·860	66·0	29·841	63·0	45·2	43·4	50·8	51·4	64·9	65·0	S. W.	10	·000	Do.
22 Wednesday, .	30 200	61·0	30·197	59·0	39·9	37·2	49·8	51·2	60 4	57·9	S. E.	10	·000	Do.
23 Thursday, . .	30·030	61·8	30·022	58·6	41·2	40·4	50·2	51·1	60·1	55·6	S. E.	5	·000	Cloudy, mild, occasional sun.
24 Friday, . . .	30·052	60·0	30·049	57·9	46·8	44·2	51·0	51·9	58·2	54·4	E.	0	010	Cloudy, mild, light showers.
25 Saturday, . .	30·112	66·0	30·091	62·8	46·0	44·8	52·4	53·0	64·9	60·2	S. E.	8	·000	Cloudy, mild, occasional sun.
26 Sunday, . . .	30·156	70 6	30·125	66·8	51·2	49 4	53·8	54·2	69·8	62·2	S. E.	10	·000	Fine, breezy, bright sun.
27 Monday, . .	30·182	66·0	30·111	63·6	51·9	50·0	55·0	55·4	64·6	57·8	S. E.	10	·000	Do.
28 Tuesday, . .	30·188	64·6	30·175	61 8	54·2	52·4	55·0	55·6	62·4	55·9	S. E.	9	·000	Breezy, cloudy, occasional sun.
29 Wednesday, .	30·280	61·6	30·277	59·4	49·9	47·5	54·6	55·4	60·2	52·7	S. E.	11	·000	Breezy, fine, bright sun.
30 Thursday, . .	30·068	63·1	30·060	60·0	35·9	33·2	51·2	53·0	61·3	52·9	S. E.	12	·000	Do.
												221	1·280	Inches.

MAY, 1874.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In earth. 5 in.	In earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Friday, ...	30·082	58·6	30·085	56·2	35·9	38·4	51·0	52·9	57·0	51·8	S. E.	12	·000	Breezy, fine, bright sun.
2 Saturday, . . .	30·180	58·0	30·188	55·2	35·1	38·0	50·8	52·0	56·1	49·1	S. E.	12	·000	Do.
3 Sunday, . . .	29·916	55·0	29·932	52·4	31·0	29·	47·0	50·2	53·8	47·5	N. W.	8	·000	Cloudy, changeable, occasional sun.
4 Monday, . . .	29·994	52·7	30·015	51·6	37·1	35·	47·6	49·8	53·1	47·8	S. E.	7	·020	Cloudy, light showers, occas. sun.
5 Tuesday, . . .	30·072	55·0	30·087	52·0	42·9	40·6	47·6	49·8	53·4	46·9	N. E.	6	·000	Breezy, cloudy, occasional sun.
6 Wednesday, . .	29·842	52·8	29·863	49·9	44·8	42·4	47·0	49·2	50·0	46·1	S. W.	4	·110	Cloudy, showery, occasional sun.
7 Thursday, . . .	29·812	52·0	29·833	50·0	34·8	32·0	45·8	46·0	51·8	46·1	N. W.	8	·010	Cly., slight thun., showy., occas. sun.
8 Friday, ...	29·772	49·0	29·803	46·0	36·0	34·2	44·2	46·8	46·9	43·8	N. W.	4	·210	Cloudy, hail showers, occasional sun.
9 Saturday, . . .	29·790	58·0	29·811	51·4	32·8	30·2	44·6	46·9	51·3	46·5	S. E.	8	·180	Cloudy, light showers, occasional sun.
10 Sunday, . . .	29·988	54·8	30·003	52·0	34·0	32·4	44·9	46·8	53·0	46·1	S. E.	9	000	Fine, mild, bright sun.
11 Monday, . . .	30·150	59·0	30·153	56·2	37·8	36·4	47·0	48·6	57·8	49·5	S. E.	12	·000	Fine, breezy, bright sun.
12 Tuesday, . . .	30·292	56·0	30·300	53·4	33·2	31·4	47·8	49·1	54·1	48·9	N. E.	4	·000	Breezy, cloudy, occasional sun.
13 Wednesday, . .	30·360	56·0	30·369	54·1	37·0	35·2	47·2	48·9	54·3	51·3	S. E.	4	·010	Cloudy, mild, light showers.
14 Thursday, . . .	30·390	57·0	30·399	54·6	44·8	42·4	48·6	49·8	55·2	51·1	S. W.	4	·000	Do.
15 Friday, ...	30·340	56·0	30·349	54·8	50·0	48·4	51·0	51·6	54·1	48·0	S. E.	10	·040	Breezy, light showers, bright sun.
16 Saturday, . . .	30·340	54·9	30·354	55·4	43·9	41·6	49·3	51·0	53·9	51·0	S. W.	0	·050	Cloudy, light showers.
17 Sunday, . . .	30·336	58·4	30·339	58·5	49·0	47·2	50·0	51·0	56·8	52·9	S. E.	0	·010	Cloudy, mild, light showers.
18 Monday, . . .	30·326	65·0	30·313	64·9	39·9	35·6	50·6	51·9	64·1	54·8	S. E.	14	·000	Fine, breezy, bright sun.
19 Tuesday, . . .	30·300	68·0	30·292	62·0	42·1	40·3	52·1	53·0	61·9	55·0	N. E.	12	·000	Do.
20 Wednesday, . .	30·260	55·0	30·275	54·0	46·0	44·2	50·6	52·4	53·1	47·6	S. E.	4	·000	Breezy, cloudy, occasional sun.
21 Thursday, . . .	29·980	58·2	29·984	58·1	44·1	42·3	51·6	52·9	57·0	50·8	S. E.	12	000	Fine, breezy, bright sun.
22 Friday, ...	29·662	50·2	29·688	50·0	49·0	47·2	50·6	52·8	49·2	48·1	N. E.	0	·070	Breezy, cloudy, showery.
23 Saturday, . . .	29·600	63·0	29·594	62·0	48·9	46·4	53·0	53·6	61·6	56·2	N. E.	10	·080	Cloudy, showery, bright sun.
24 Sunday, . . .	29·600	55·1	29·615	54·3	51·8	49·6	51·3	53·2	54·0	52·1	N. E.	0	.280	Cloudy, showery, changeable.
25 Monday, . . .	29·870	58·0	29·875	57·0	50·6	48·3	51·4	53·0	55·2	52·9	N. E.	0	·000	Breezy, cloudy, changeable.
26 Tuesday, . . .	30·048	61·0	30·045	59·4	52·2	50·0	52·1	53·6	59·0	55·8	N. E.	0	·000	Do.
27 Wednesday, . .	29·990	63·0	29·984	62·9	51·0	49·3	52·2	54·3	61·2	57·0	S. E.	4	·000	Cloudy, mild, occasional sun.
28 Thursday, . . .	29.944	56·4	29·953	56·0	51·0	49·6	52·2	54·1	55·1	52·8	S. W.	0	·060	Cloudy, showery, changeable.
29 Friday, ...	29·850	63·1	29·844	63·0	50·5	48·4	52·8	54·2	61·4	57·8	S. W.	3	·550	Cloudy, wet, occasional sun.
30 Saturday, . . .	29·730	64·6	29·718	67·0	49·8	47·6	53·6	55·1	63·6	58·0	S. W.	6	·000	Breezy, cloudy, occasional sun.
31 Sunday, . . .	29·790	64·8	29·778	65·6	54·4	52·0	54·1	55·3	63·0	58·0	S. W.	2	·030	Breezy, showery, occasional sun.
												179	1 710	inches.

JUNE, 1874.

DATE. Day, At 12 o'Clock, P. M.	BAROMETER. Observed Height.	Therm.	Corrected for Temperature only.	THERMOMETER. Max.	Min.	On Grass.	In Earth. 5 in.	10 in.	Dry.	Wet	WIND. Direction.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
1 Monday, . .	29·926	64·4°	29·914	67·0°	54·9°	52·3°	55·0°	56·1°	62·9°	58·0°	S. W.	0	. .	Breezy, cloudy, changeable.
2 Tuesday, . .	29·878	64·0	29·866	66·8	56·1	54·2	55·0	56·4	64·0	55·0	S. W.	0	·010	Breezy, cloudy, light rain.
3 Wednesday, .	30·220	65·2	30·205	66·8	49·0	47·3	55·6	56·9	69·0	57·8	S. E.	12	. .	Fine, breezy, bright sun.
4 Thursday, . .	30·420	73·4	30·383	73·1	50·0	48·6	57·4	58·2	72·0	64·0	S. W.	10	. .	Do.
5 Friday, . .	30·340	59·0	30·343	59·0	56·4	53·2	56·9	58·2	58·0	54·8	S. E.	0	·020	Cloudy, light showers, changeable.
6 Saturday, . .	30·252	64·8	30·237	63·8	47·9	45·8	55·2	57·1	62·8	54·1	S. W.	12	. .	Fine, breezy, bright sun.
7 Sunday, . .	30·286	65·8	30·271	65·2	43·2	41·6	54·4	56·1	63·4	55·0	S. W.	15	. .	Fine, mild, bright sun.
8 Monday, . .	30·292	71·1	30·261	70·5	50·8	48·6	56·6	58·1	69·4	59·8	S. W.	12	. .	Do.
9 Tuesday, . .	30·204	71·4	30·173	73·0	54·2	52·8	58·1	59·8	70·4	62·4	S. W.	10	. .	Breezy, cloudy, bright sun.
10 Wednesday, .	30·278	64·0	30·265	63·1	51·8	49·6	56·6	59·1	62·4	57·8	S. W.	12	. .	Do.
11 Thursday, . .	30·150	65·2	30·137	66·2	53·0	50·9	57·4	59·0	64·2	59·0	S. W.	4	. .	Breezy, cloudy, changeable.
12 Friday, . .	30·502	62	30·493	63·2	42·5	40·3	56·1	58·0	61·8	52·1	N. E.	15	. .	Fine, breezy, bright sun.
13 Saturday, . .	30·526	62	30·517	62·1	41·0	33·9	56·6	58·1	61·0	51·6	N. E.	15	. .	Do.
14 Sunday, . .	30·560	64	30·545	64·4	40·8	35·4	55·5	57·8	62·1	53·8	N. E.	15	. .	Do.
15 Monday, . .	30·680	66	30·658	65·9	41·9	35·9	57·1	58·8	64·4	56·5	N. E.	14	. .	Do.
16 Tuesday, . .	30·502	65	30·487	66·0	46·1	39·8	58·2	60·0	63·9	55·8	N. E.	15	. .	Do.
17 Wednesday, .	30·354	68	30·338	67·4	50·0	41·4	59·0	60·0	66·2	57·4	N. E.	15	. .	Do.
18 Thursday, . .	30·400	67	30·379	67·9	49·6	41·8	59·6	61·1	65·6	59·2	N. E.	14	. .	Do.
19 Friday, . .	30·372	66	30·331	65·0	45·0	38·5	57·2	60·0	63·8	58·0	N. W.	0	. .	Cloudy, mild, changeable.
20 Saturday, . .	30·244	68	30·218	67·9	48·0	40·1	59·0	60·6	66·9	57·9	N. W.	11	. .	Fine, breezy, bright sun.
21 Sunday, . .	30·040	69	30·014	69·2	49·6	41·9	59·0	61·0	68·9	65·0	S. E.	4	. .	Fine, mild, overcast, changeable.
22 Monday, . .	29·980	67	29·961	68·2	49·2	41·5	58·1	60·0	65·2	56·1	S. E.	8	. .	Breezy, occasional sun.
23 Tuesday, . .	29·756	70	29·727	69·8	56·1	49·9	59·1	60·2	69·1	58·1	S. W.	9	·120	Breezy, showery, occasional sun.
24 Wednesday, .	29·686	62	29·680	62·0	44·4	37·9	55·8	58·1	60·0	54·0	S. W.	8	·020	Do.
25 Thursday, . .	29·780	68	29·756	68·2	47·9	43·5	56·4	58·6	65·6	57·8	S. W.	10	. .	Cloudy, changeable, occasional sun.
26 Friday, . .	29·730	69	29·701	68·9	43·9	37·9	58·4	59·2	67·4	58·4	N. E.	15	. .	Breezy, bright sun, thunder.
27 Saturday, . .	29·744	66	29·725	66·9	50·8	45·2	57·6	60·0	64·6	55·1	S. W.	10	. .	Cloudy, mild, occasional sun.
28 Sunday, . .	29·832	68	29·808	69·0	45·5	39·5	57·9	59·6	66·6	58·2	S. E.	12	. .	Fine, breezy, bright sun.
29 Monday, . .	29·894	62	29·888	62·0	45·1	37·8	57·4	59·2	60·9	57·2	S. E.	0	. .	Cloudy, mild, changeable.
30 Tuesday, . .	29·838	68	29·814	67·9	52·0	48·1	59·1	60·4	66·8	62·0	S. W.	0	·050	Cloudy, light showers, changeable.
												277	·220	Inches.

JULY, 1874.

DATE.	BAROMETER.			THERMOMETER.							WIND.	HOURS OF SUNSHINE.	RAIN IN INCH.	WEATHER, AND GENERAL REMARKS.
Day, At 12 o'Clock, P. M.	Observed Height.	Therm.	Corrected for Temperature only.	Max.	Min.	On Grass.	In Earth. 5 in.	In Earth. 10 in.	Dry.	Wet.	Direction.			
		°		°	°	°	°	°	°	°				
1 Wednesday, . .	29·780	67	29·761	66·2	56·9	53·6	58·9	60·0	65·4	63·2	S. W.	0	·220	Cloudy, light showers, changeable.
2 Thursday, . .	29·642	69	29·613	68·9	59·0	56·1	59·4	60·2	67·2	61·4	S. W.	2	·120	Breezy, showery, occasional sun.
3 Friday, . . .	29·710	69	29·681	68·0	56·5	50·0	59·2	60·9	66·8	60·4	S. W.	6	·000	Breezy, cloudy, occasional sun.
4 Saturday, . .	29 900	66	29·879	66·2	52·8	47·8	57·2	59·8	64·5	67·8	S. W.	8	·240	Breezy, heavy showers, occasional sun.
5 Sunday, . . .	30·248	65	30·283	66·8	53·0	57·9	56·0	58·6	64·4	57·4	S. W.	6	·000	Breezy, cloudy, occasional sun.
6 Monday, . . .	30·310	68	30·284	67·4	46·1	38·4	57·0	58·9	66·1	56·8	S. W.	10	·000	Do.
7 Tuesday, . . .	30·142	74	30·098	73·0	58·0	47·9	59·1	60·6	74·8	61·2	S. W.	14	·000	Breezy, cloudy, bright sun.
8 Wednesday, .	30·080	72	30·048	72·0	55·8	50·0	60·0	61·2	70·6	68·8	S. W.	4	·000	Cloudy, mild, occasional sun.
9 Thursday, . .	30·176	69	30·145	68·4	57·0	55·2	60·8	62·0	67·1	62·9	S. W.	6	·000	Do.
10 Friday, . . .	30·226	62	30·218	62·0	58·0	58·0	59·8	62·4	60·9	57·9	S. E.	0	·000	Cloudy, mild, changeable.
11 Saturday, . .	30·150	67	30·129	68·0	57·8	45·8	60·2	61·4	64·5	58·9	S. E.	8	·000	Cloudy, mild, occasional sun.
12 Sunday, . . .	30·062	64	30·049	67 0	55·4	53·0	60·0	61·0	67·0	59·5	S. E.	0	·020	Breezy, cloudy, light showers.
13 Monday, . . .	30·050	67	30·029	67·1	56·1	55·0	60·8	61·4	65·4	64·6	S. E.	4	·010	Cloudy, light showers, occasional sun.
14 Tuesday, . . .	30·068	70	30·037	70·1	57·0	52·9	60·0	61·5	68·2	65·2	S. W	6	·120	Breezy, showery, occasional sun.
15 Wednesday, . .	30·210	70	30·179	69·9	58·1	49·9	61·0	62 0	68·1	63·6	S. E.	0	·000	Cloudy, mild, changeable.
16 Thursday, . .	30·190	73	30·153	72·0	51·8	44·0	61·1	62·0	71·4	69·9	S. E.	12	·000	Fine, breezy, bright sun.
17 Friday, . . .	30·228	76	30·180	74·6	54·0	47·9	62 6	68·8	74·9	71·9	S. E.	12	·000	Do.
18 Saturday, . .	30·240	75	30·197	74 6	56·0	48·2	63·1	64·4	74·2	71·0	S. E.	14	·000	Do.
19 Sunday, . . .	30·124	76	30·076	79·0	53·4	47·4	63·8	64·6	74·6	72·2	S. W	8	·000	Cloudy, mild, occasional sun.
20 Monday, . . .	29·966	71	29·937	71·0	52·8	45·8	62·0	63·6	69·0	66·8	S. W	8	·000	Do.
21 Tuesday, . . .	29·770	67	29·751	66·3	58·8	55·2	60·1	62·4	65·0	63·1	S. W.	9	·150	Breezy, showery, occasional sun.
22 Wednesday, . .	29·882	72	29·847	72·6	58·0	48·9	60·0	62·0	72·2	68·9	S. W.	6	·050	Do. [sional sun.
23 Thursday, . .	29·882	65	29·818	65·8	51·4	44·2	57·6	60·4	64·0	58·6	S. W	5	·530	Cloudy, heavy showers, thunder, occa-
24 Friday, . . .	29·884	67	29·865	67 2	50·2	47·0	57·6	60·2	65·9	54·8	N. E.	6	·830	Do.
25 Saturday, . .	29·906	69	29·882	70·0	48·2	42·6	58·0	60·4	67·0	59·9	S. W.	6	·150	Do.
26 Sunday, . . .	29·636	69	29·612	69·2	53·6	47·9	57·5	59·6	67·0	62·6	S W.	4	·450	Breezy, showery, occasional sun.
27 Monday, . . .	29·632	71	29·603	70·0	51·0	45·2	57·6	59·9	69·6	64·8	S. W.	9	·000	Fine, mild, bright sun.
28 Tuesday, . . .	29·600	64	29·588	63·6	47·9	42·8	56·9	59·1	62·4	59·9	S. E.	6	·240	Breezy, showery, occasional sun.
29 Wednesday, . .	29·820	70	29·791	70·0	45·9	42·0	57 6	59·8	69·0	65·8	S. W.	14	·020	Fine, breezy, bright sun, light showers.
30 Thursday, . .	29·924	66	29·905	68·4	53·9	48·9	58·1	60·4	67·0	64·0	S. W.	6	·000	Breezy, cloudy, occasional sun.
31 Friday, . . .	29·924	66	29·905	65·1	57·0	58·8	58·6	60·6	64·1	62·6	S. W.	0	·020	Breezy, cloudy, light showers.
												199	2·670	inches.

II.—Departments of the Society.

1. *Agriculture.*

a. The Annual Show of Cattle, Poultry, and Implements, is held in Spring.

b. The Winter Show of Farm and Dairy Produce is held in December.

c. Annual Show of Horses and Rams in Autumn.

d. Chemical Analyses of Agricultural Produce, Soils, Manures, &c., are performed in the Laboratory.

e. The Agricultural Museum open daily (Sundays excepted) from 11 to 4 o'Clock.

III.—Botanic Gardens and Museum of Botany, Glasnevin.

Open Free, daily, at 12 o'clock, and closed at six o'Clock, P. M., from 1st April to 30th September; and 4 o'Clock, P. M., or Sunset, from 1st October to 31st March. The Conservatories are open at 1 o'Clock, P. M., and closed one hour earlier than the time for closing the Garden.

On Sundays the Garden is open at 2 o'Clock, P. M. The Conservatories are open at 2½ o'Clock, P. M.

Persons producing Members' Orders are admitted free at any time.

IV.—Museum of Natural History,

Illustrative of Zoology, Mineralogy, Geology, and Ethnology.

Open Free on Mondays, Tuesdays, Thursdays, and Saturdays, at 11 o'Clock, A.M., and closed at 5 o'Clock, P. M., from 1st April to 30th September; and at 3 o'Clock, P. M., from 1st October to 30th March; also on the Evenings of Tuesdays and Thursdays, from 7½ to 10 o'Clock.

V.—School of Art.

Open from 1st October to 31st July in each year for instruction in Elementary and Advanced Drawing, Figure and Landscape Painting, and in Mechanical and Architectural Drawing.

Classes for Ladies and Gentlemen.—From 10 o'Clock, A. M., to 3 o'Clock, P. M., daily, Saturdays and Sundays excepted. Fees—12*s.* to 60*s.* per Session of 5 months.

Classes for Artisans, etc.—*Females*—From 10 o'Clock, A. M., to 12 o'Clock on the Mornings of Tuesdays and Thursdays. *Males*—From 7 to 9 o'Clock, P. M., on the Evenings of Mondays, Wednesdays, and Fridays. Fees—From 1*s.* 6*d.* to 3*s.* per month, and from 9*s.* to 12*s.* per Session of 5 months.

Prospectuses to be had on application.

☞ *Prizes are awarded Annually at Examinations and Exhibitions.*

VI.—Library,

Which contains about 62,000 volumes, is open daily (Sundays and holidays excepted) from 10 o'Clock, A. M., to 10 o'Clock, P. M.

Any person having a recommendation from a Member, or who may have obtained permission from the Library Committee, is admitted to read in the Library.

Members have the privilege of borrowing a limited number of books.

The Conversation and Reading Room, which is provided with a large collection of Periodicals, including Newspapers, and in which all the recently purchased Works remain for one Month, is set apart for the exclusive use of the Members.

The Journal of the Royal Dublin Society is sent in Exchange for the Transactions and Publications of the following Institutions, &c.:

Royal Acad. of Sciences, Amsterdam.
Natural History Society, Belfast.
Chemico-Agricultural Society of Ulster, Belfast.
Royal Academy of Sciences, Berlin.
German Geological Society, Berlin.
Imperial Acad. of Sciences, Bordeaux.
Societè des Sciences Physiques, &c., Bordeaux.
American Academy, Boston.
Natural History Society, Boston.
Institution for the Advancement of Science, Liter., and the Arts, Bristol.
Academy of Sciences, Brussels.
Society of Natural Sciences, Buffalo, U. S.
Geological Museum, Calcutta.
Philosophical Society, Cambridge.
Mechanics' Institute, Clonmel.
Royal Society of Science, Copenhagen.
Royal Institution, Cork.
Royal Cornwall Polytechnic Society, Falmouth.
Academy of Sciences, Dijon.
Royal Irish Academy, Dublin.
Trinity College Library, Dublin.
College of Physicians, Dublin.
Royal Geological Society of Ireland.
Geological Survey of Ireland, Dublin.
Royal College of Surgeons, Dublin.
University Philos. Society, T. C. D.
Statistical Society, Dublin.
College of Science, Dublin.
Royal Society, Edinburgh.
Highland Agricul. Society, Edinburgh.
Wernerian Society, Edinburgh.
Society of Arts, Edinburgh.
Advocates' Library, Edinburgh.
Die Königlich Sachsischen Gesellschaft der Wissenschaften zu Leipsig.
Society of Physics and Natural History, Florence.
Institution of Engineers, Glasgow.
Society of Physics, Genoa.
Société Vaudoise des Sc. Nat., Lausanne.
Geological and Polytechnic Society of the West Riding of Yorkshire, Leeds.
Philosoph. and Literary Society, Leeds.
Historic Society of Lancashire and Cheshire, Liverpool.
Literary and Philos. Society, Liverpool.
British Archæological Society, London.
Royal College of Surgeons, London.
Royal Society, London.
Geological Society, London.
Linnean Society, London.
Royal Geographical Society, London.
Civil Engineers' Institute, London.
Royal Asiatic Society, London.
Zoological Society, London.
Royal Agricultural Society of England.
Statistical Society, London.
Pathological Society, London.
Royal Astronomical Society, London.
Department of Science and Art, London.
Great Seal Patent Office, London.
Society of Arts, London.
Geological Survey, London.
Royal Institution, London.
London and Middlesex Archæol. Society.
Meteorological Office, Westminster.
British Museum.
La Société Imperiale d'Agriculture, d'Histoire Naturelle, et des Arts Utiles, Lyons.
Academie Imperiale de Lyons.
Literary and Philosophical Society of Manchester.
The Royal Institution, Manchester.
Geological Society, Manchester.
Somersetshire Archæological and Natural History Society.
Northampton Architectural Society.
Philos. Institute of Victoria, Melbourne.
Public Library, Melbourne.
Imperial Institute of Science, Milan.
State Survey and Univ., Missouri, U.S.
Academy of Science of St. Louis, Missouri, U. S. A.
Imperial Institute of Science, Modena.
Royal Acad. of Science, Munich (2 cop.)
Das Bibliothekariat der K. B. Academie der Wisschschaften, Munich.
Editors of Silliman's Journal of Science and Art, New York.
Academy of Sciences, New Orleans, Louisiana, U. S. A.
Bodleian Library, Oxford.
Ashmolean Society, Oxford.
Ecole Polytechnique, Paris.
Geological Society, Paris.
L'Ecole Imp. des Mines, Paris.
L'Academie des Sciences de l'Institut Imperial de France, Paris.
Jardin des Plantes Bibliotheque, Paris.
Societés Savantes de la France et des l'Etrangés, Paris.
American Philosophical Society, Philadelphia, U. S.
Natural History Society, Philadelphia.
Plymouth Institution and Devon and Cornwall Nat. Hist. Society, Plymouth.
Literary and Historical Society, Quebec.
Academy of Sciences, Rouen.
Imperial Academy, St. Petersburgh.
Central Physical Observatory of Russia, St. Petersburgh.
Royal Academy of Science, Stockholm.
Société des Sciences Naturelles de Strasbourg.
Canadian Institute, Toronto.
University College, Toronto.
Academy of Sciences, Toulouse.
Royal Academy, Turin.
Royal Industrial Museum, Turin.
Editor of Cosmos *di Guida Coro*, Turin.
Michigan State Agricultural Society, Lausing, Michigan, U. S.
Wisconsin State Agricultural Society, Wisconsin.
Royal Soc. of Sciences, Upsala, Sweden.
Venetian Society of Science, Literature, and the Arts, Venice.
Verein für Vaterländische Naturkunde, Stuttgart.
Imperial Academy of Sciences, Vienna.
Royal Zoological Society, Vienna.
W. Haidinger, of Vienna, as Editor of the "Jahrbuch der K. K. Geologischen Reichsanstalt."
Smithsonian Institute, Washington, U. S.
Stevens' Institute of Technology, Hoboken, U. S.